Volume 23, Number 12 June 30, 1969

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 21777 and 22674.

21618 (JUL-531-CA) 2 Θ-VALUE FOR THE X-RAY SPECTRAL ANALYSIS WITH AMMONIUM DIHYDROPHOSPHATE, (011), 2d = 10.648 A AS ANALYZER CRYSTAL. Freiburg, C.; Reichert, W. (Kernforschungsanlage, Juelich (West Germany). Zentrallabor fuer Chemische Analyse). June 1968. 84p. (In German). Dep.

In the first table given, in column 1 the 2θ value is arranged by increasing wavelength, in the second column is the element symbol for the wavelength concerned. Table 2 is a reversal of table 1, arranged by increasing atomic number of the element. (M.C.G.)

21619 (NYO-3086-8, pp X.1-15) SIMULTANEOUS DETERMINATION OF ^{55}Fe AND STABLE IRON BY LIQUID SCINTILLATION COUNTING. Cosolito, Frank J.; Cohen, Norman; Petrow, Henry G. (New York Univ., N. Y. Inst. of Environmental Medicine).

A liquid scintillation method using solvent extraction for simultaneous determination of iron-55 and stable iron is described, and sample preparation procedures for analyzing biological materials are briefly discussed. (W.H.K.)

21620 (RFP-1324) PHYSICAL INVENTORY OF THE ENRICHED URANIUM IN A SOLUTION SYSTEM. Rothe, Robert E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Mar. 12, 1969. Contract AT(29-1)-1106. 10p. Dep. CFSTI.

A high precision inventory of enriched uranium in solution form is reported, as well as techniques that contribute to the precision. Both statistical uncertainties due to measurements and imponderable sources of errors are discussed. Based on an evaluation of these uncertainties, the expected variation between successive future inventory measurements will lie between 1 and 2%. (auth)

21621 USE OF LIQUID SCINTILLATION QUENCHING TO QUANTITATE LIPID MASS. Snyder, Fred; Moehl, Anita (Oak Ridge Associated Universities, Tenn.). Anal. Biochem., 28: 503-9(Apr. 4, 1969).

A new method for detecting 10 to 100 μg lipid mass in unmodified liquid scintillation spectrometers was developed by taking advantage of color quenching in such systems. The color, which quenches an isolated scintillation source, is produced by an H_2SO_4-lipid reaction carried out in a scintillation vial at 200°C for 60 min. The isolated source, a glass tube containing a mixture of plastic scintillator and β emitter (^{14}C), is then inserted into the vial containing the colored solution for radioassay. The counting rate of the source is decreased as a linear function by the color intensity of the H_2SO_4-lipid solution. (auth)

21622 8-QUINOLINOL EXTRACTION AND SPECTROPHOTOMETRIC DETERMINATION OF URANIUM WITH ARSENAZO III. Motojima, Kenji; Yamamoto, Tadashi (Japan Atomic Energy Research Inst., Ibaraki). Bunseki Kagaku, 18: 208-13(Feb. 1969). (In Japanese).

Uranium(VI) forms a complex with arsenazo III in 5 M perchloric acid. It has an absorption maximum at 655 mμ; the molar absorptivity is ca. 7.1×10^4, and Beer's law holds over the range of 0 to 2.0 μg U/ml. Zirconium, thorium, and rare earths also form complexes with Arsenazo III in an acidic solution, which interferes with the determination of uranium. Uranium, however, can be separated from the elements by 8-quinolinol extraction. Uranium is extracted with chloroform as an 8-quinolinolate from the solution whose pH was adjusted to 6.0 to 6.5, after masking the interfering elements by addition of EDTA. Uranium is back-extracted with a definite volume of 0.02% arsenazo III–5 M perchloric acid solution. The absorbence of the aqueous phase is measured at 660 mμ. In this case, the absorption maximum shifts to 660 mμ and the molar absorptivity is ca. 6.7×10^4. (NSA of Japan)

21623 AUTOMATED METHOD FOR THE DETERMINATIONS OF DEUTERIUM OXIDE IN WATER AND BIOLOGIC FLUIDS. Robbins, R. C. (Univ. of Florida, Gainesville). Clin. Chem., 15: 56-60(Jan. 1969).

An automated system for determination of D_2O in water and physiologic fluids is described. The instruments arranged in a continuous system include a sampler equipped with sample leveling and constant volume attachments, proportioning pump, dialyzer, ir spectrophotometer equipped with a pen-position readout system for use with a stri-chart recorder, beam attenuator, demountable cells with Irtran-2 windows, and a recorder. The flow through the system is diagramed, and parameters for the operation of the D_2O determination system are itemized. The sampler is capable of processing 60 samples/hr. The precision of the automated D_2O system is indicated by the reproducibility of peak heights over a range of D_2O concentrations from 0.125 to 1%. The magnitude of the standard deviation appears to be random over the ranges of D_2O concentration observed. The accuracy of the automated system shown by the recoveries of D_2O were for water, plasma, urine, and whole blood, 99.9, 101.1, 100.2, and 101.7%. Recovery of D_2O from water or plasma is more exact than from urine or whole blood. This automated system is capable of accurate and precise determinations within the 0.2 to 0.3% range. (BBB)

21624 CONTRIBUTION TO THE EVALUATION OF INORGANIC AND ORGANICALLY BOUND IODINE IN CEREBROSPINAL FLUID. Bednar, J.; Soumar, J.; Smejkal, V. (Research Inst. of Endocrinology, Prague). Endokrinologie, 52: 97-101(1967). (In German).

The accuracy of determination of total I in cerebrospinal fluid was evaluated by alkaline oxidation. The amounts of I/ml found decreased over the range of from 1 to 5 ml of sample, with estimated errors of ~21% between samples. By indirect I assay, using blood serum as a protein carrier, of known I content, the inorganic I in the cerebrospinal fluid was measured with only 5% error. The protein-bound I in the cerebrospinal fluid could not be evaluated by this procedure. (BBB)

Chemical Procedures

Refer also to abstract 21783.

21625 (AAEC/TM-144) THE SPECTROPHOTOMETRIC DETERMINATION OF SILICON IN THORIUM METAL, THORIUM OXIDE, URANIUM METAL, URANIUM OXIDE, AND BERYLLIUM METAL. Pakalns, P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug. 1962. 6p. Dep.

Several modifications are necessary when applying the classical molybdenum blue spectrophotometric method to the determination of silicon in high-purity thorium, uranium, and beryllium compounds. Detailed directions for the estimation of as little as 1 ppM of silicon in these materials are given. No separations are required. (auth)

21626 (BARC-356) FLAME SPECTROPHOTOMETRIC DETERMINATION OF EUROPIUM AND YTTRIUM IN RARE EARTH CONCENTRATES. D'Silva, A. P.; Venkitachalam, T. V.; Narayanaswamy, U. R. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 13p. Dep.

The determination of europium and yttrium oxides using conventional techniques is difficult, especially when the matrix composition varies widely. The flame photometric method described does not suffer from this limitation. The method was developed after suitably converting a Hilger Uvispek spectrophotometer to obtain recordings of flame spectra. Rare earth concentrates containing europium oxide in the range 0.1 to 2.0%, and yttrium oxide in the range 10 to 100%, were analyzed with a reproducibility of ±2%. (auth)

21627 (EIR-142) STANDARDIZATION OF THE DEUTERIUM CONTENT OF HEAVY WATER. Baertschi, P.; Rosatzin, H. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Oct. 1968. 20p. (In German). Dep.

An observed uncertainty of several hundredths percent in absolute determination of the relative D content of D_2O samples makes the production of a reference standard of D_2O as exact as possible appear desirable. The production and absolute determination of a D_2O primary standard with a D content of 99.9983 ± 0.0002 at. % is described. By comparison of the ir absorption at 2.5 μ and comparison of the density, the D contents of three secondary standards were determined. These two comparison methods gave error limits of ±0.002% D. (tr-auth)

21628 EVALUATION OF THE VACUUM FUSION METHOD FOR THE DETERMINATION OF OXYGEN AND NITROGEN IN THE REFRACTORY METALS. Tankins, E. S. (Naval Air Warminster Development Center, Johnsville, Pa.). Met. Soc. Conf., 34: Pt. 1, 325-34(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

Analytical procedures for determining oxygen contents of numerous refractory metals and iron samples were investigated in detail. Results show excellent reproducibility. Runs were made with pure iron, pure platinum, and platinum–iron baths. Iron baths are recommended for molybdenum and tungsten and platinum and platinum–iron baths are recommended for niobium and tantalum. No interference was found with W, Mo, Co, Ni, Cr, Nb, Ta, and V in an iron bath. Hf, Zr, and Ti in an iron bath gave erratic results. (auth)

21629 DECOMPOSITION AND SEPARATION PROCEDURES FOR THE QUANTITATIVE MICROANALYSIS OF RUTHENIUM AND RUTHENIUM ALLOYS. Scharner, P.; Baresel, D. (Forschungsinstitut, Berlin). Mikrochim. Acta, No. 2, 304-11(1969). (In German).

A method for the quantitative determination of microamounts of metallic ruthenium and also of ruthenium in Ru–Pt and Ru–Pt–Al alloys was developed. The samples are treated in a sealed tube at 520–540° with a mixture of $K_2S_2O_7$ and KCl. The dissolved ruthenium is separated as RuO_4, by distillation with H_2SO_4–$HClO_4$, from the accompanying elements and determined photometrically with 2,4-diphenylthiosemicarbazide. The total error for the decomposition, distillation, and photometric determination lies at around ±5%. (auth)

21630 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM IN ALLOYS USING PICRAMINAZOCHROME. Zadumina, E. A.; Cherkesov, A. I. Zavod. Lab., 35: No. 1, 10-12 (1969). (In Russian).

A method is proposed for the determination of zirconium in nickel and magnesium alloys with a Zr content of 0.1% and in aluminum alloys with a Zr content of >2% using 4,5-dihydroxy-3-[(2-hydroxy-3,5-dinitrophenyl)azo]-2,7-naphthalenedisulfonic acid. The method was used for the analysis of industrial samples of magnesium and nickel alloys containing 0.1 to 1.0% Zr and aluminum alloys containing up to 3% Zr. (tr-auth)

21631 FLUORIMETRIC DETERMINATION OF TERBIUM AS IMPURITY IN YTTRIUM OXIDE. Gava, S. A.; Poluektov, N. S. Zavod. Lab., 35: No. 1, 20-3(1969). (In Russian).

Optimum conditions are given for the determination of terbium in high-purity yttrium oxides by measuring the luminescence of its ions in a crystal phosphor. The greatest fluorescence from terbium was observed in yttrium oxide obtained by calcination of yttrium sulfate. Mercury lamp SVD-120A with light filter UFS-2 was used as the source of excitation, and the luminescence was recorded by spectrograph ISP-51 with photoelectric attachment FEP-1. The sensitivity of the determination was 2×10^{-5}%. (tr-auth)

21632 ANALYTICAL CHEMISTRY. VOLUME 9. Dewey, R. D.; Mapes, R. S.; Reynolds, T. W. Progress in Nuclear Energy Series IX. Oxford Pergamon Press, 1969. 353p. £7.

The following are presented in this volume: Computed x-ray wavelengths (with wavelength tables); practical approach to electron probe microanalysis; study of x-ray fluorescent efficiency (with efficiency tables); study of x-ray mass absorption coefficients (with tables of coefficients). (UK)

21633 ABSORPTIOMETRIC DETERMINATION OF TANTALUM AND NIOBIUM FROM ONE SAMPLE. Zaboeva, M. I.; Kustova, A. M.; Barkovskii, V. F. Byull. Nauch.-Tekh. Inform., Min. Geol. SSSR, Ser. Izuch. Veshchest. Sostava Miner. Syr'ya Obogashch. Rud, No. 3, 10-15(1967).

Lanthanum is determined with butylrhodamine (I), and the Nb as the reduced molybdoniobophosphate hetero-complex. Remove SiO_2 by treatment of the sample with HF, separate from W by precipitation of Ta and Nb with alkali, and separate from Fe, Ti, and V by precipitation of Ta and Nb with tannin from a solution 2 to 2.5$\underline{N}$ in HCl. The oxide sample is then fused with 1 g of $K_2S_2O_7$ at 600 to 650° for ≈9 min, cooled and 3 drops of concentrated H_2SO_4 is added, fused again, cooled, and dissolved in 16 ml of 10% tartaric acid solution–5% ammonium oxalate solution (5 : 3); 6 ml of H_2SO_4 (1 : 1) is added and diluted to 100 ml. For the determination of Nb, to 10 ml of this solution add 10 ml of 0.5$\underline{N}$-H_2SO_4, 2 ml of 0.06% Na_2HPO_4 solution and 4.4 ml of 5% $(NH_4)_6Mo_7O_{24}$ solution and set aside for 15 min. Then add 0.1$\underline{N}$-$KMnO_4$ to produce a pink color, and 8 ml of 12$\underline{N}$-H_2SO_4, and after exactly 1 min add 1 ml of 0.5% $SnCl_2$ solution and dilute to 50 ml with 3$\underline{N}$-H_2SO_4. After 10 min measure the extinction against H_2O. For the determination of Ta, to 5 ml of the initial solution, add 2 ml of 15N-H_2SO_4, 1 ml of 0.915% I solution, 6 ml of toluene and 1 ml of 20% KF solution, shake for 1 min, centrifuge off the extract, and after 40 min measure its extinction against toluene. The method can be used to determine Ta and Nb in ores. (Referativnyi Zh.)

21634 DETERMINATION OF SMALL AMOUNTS OF BERYLLIUM IN MATERIALS OF COMPLEX COMPOSITION. Galkina, L. L. Byull. Nauch.-Tekh. Inform., Min. Geol. SSSR, Ser. Izuch. Veshchest. Sostava Miner. Syr'ya Obogashch. Rud, No. 3, 19-23 (1967). (In Russian).

Fuse the sample (<0.5 g) with 3 g of KHF_2 in a platinum dish to obtain a clear melt, cool, add 10 ml of H_2SO_4 (1 : 1), heat until fuming ceases, and fuse at 500 to 600°. Dissolve the melt in 10 ml of HCl (1 : 1), evaporate to a volume of 2 to 3 ml, add 15 ml of saturated NaCl solution, boil for several minutes, dilute to 25 ml with saturated NaCl solution, and filter. Add 5 to 10 ml of 50% EDTA solution to 20 ml of the filtrate, adjust the pH to 9 to 10 with 20% aqueous NH_3, and shake for 1 min with 10 ml of butyric acid. Wash the upper (organic) layer (containing Be butyrate) with saturated NaCl solution containing a few drops of the EDTA solution and H_2O_2 solution (2 × 10 ml), then reextract the Be by shaking for 1 min with 5 ml of $CHCl_3$ and 5 ml of concentrated HNO_3. Evaporate this extract (the lower layer) almost to dryness, add 3 ml of H_2SO_4 (1 : 1) and evaporate to dryness. Dissolve the residue by heating with 10 ml of H_2O, and dilute to 25 ml. Make an aliquot of this solution alkaline to Congo red with 10% NaOH solution, add 1 ml of buffer solution of pH 13 (28.6 g of H_3BO_3 and 96 g of NaOH in 1 liter) and 1 ml of 0.02% morin solution, dilute to 10 ml, and compare the intensity of fluorescence, in uv radiation, of the test solution with that of a standard series containing 0.1 to 1.6 μg of BeO in 10 ml, or measure the intensity of fluorescence of the test solution in a fluorimeter. The method is sensitive to 5×10^{-5}% of Be. (Referativnyi Zh.)

21635 DETERMINATION OF TELLURIUM IN MATERIALS CONTAINING CARBONACEOUS MATTER AND A LARGE AMOUNT OF IRON. Voronkova, M. A.; Butkina, T. A. Byull. Nauch.-Tekh. Inform., Min. Geol. SSSR, Ser. Izuch. Veshchest. Sostava Miner. Syr'ya Obogashch. Rud, No. 3, 29-31(1967). (In Russian).

Samples (1 to 2 g) are ignited with 5 g of Na_2CO_3 for 1 to 1.5 hr at 500 to 550° with access to air; then add 5 g of Na_2O_2, mix, dry, and fuse. Extract the melt with H_2O, add concentrated HCl and remove the silica after it has been dehydrated. Determine Te in the filtrate absorptiometrically, from the color of its colloidal solution (after adding Sb^{3+}), or with butylrhodamine after precipitating Se plus Te with $H_2PO_2^-$ from 6$\underline{N}$-HCl medium with As as collector (Ivankova and Blyum, Analyt. Abstr., 8: 4998, 1961)). Both methods give concordant results. (Referativnyi Zh.)

21636 2:4 DIHYDROXY BENZOIC ACID AS A REAGENT IN INORGANIC ANALYSIS COLOUR REACTIONS WITH CATIONS. Srivastava, K. C. (BITS, Pilani, India). Chem. Age India, 18: 147(1967).

The compound 2,4-dihydroxybenzoic acid has been found to be a sensitive colorimetric reagent for Fe(III), V(V), and U(II) ions. The color of the iron chelate is pink, V chelate yellow, and uranyl ion produces a characteristic brown color. The reagent is to be used as 0.1% alcoholic solution, which gives no color in solution. (auth)

21637 THE BIAMPEROMETRIC TRITRATION OF IODIDE WITH CERIUM(IV) SULFATE IN THE PRESENCE OF BROMIDE

AND/OR CHLORIDE. Smithuis, L. O. M. J.; Rutten, W. J. (Rijksuniversiteit, Utrecht). Pharm. Weekbl., 101: 1041-3 (Nov. 18, 1966). (In Dutch).

A method for determination of I is reported, which makes use of a dead-stop electrochemical arrangement. The titration is performed on a 10-ml scale with good results for 0.01M I^- in the presence of not greater than tenfold Br^-. A potential difference of 25 mV between 2 electrodes in the solution is maintained, and 0.01N Ce(IV) is used as a titrant. The current is monitored, and when CCl_4 is present to dissolve the I_2 which is formed, a sharp minimum in the current signifies the end point. The end current is null in the absence of Br^-, and the end point has finite current with Br^-/Br_3^- present, but is still sharp; chloride does not affect the curve appreciably. The relative error at this level is 0.2%. Bromide cannot be determined by this procedure, since Ce(IV) does not oxidize it completely. (BBB)

21638 DIRECT SPECTROCHEMICAL METHOD (DC ARC CATHODE REGION) FOR DETERMINATION OF 35 IMPURITIES IN THORIA AND ZIRCONIA MATRICES. Avni, R. (Israel Atomic Energy Commission, Beer-Sheva). Spectrochim. Acta, Part B, 24: 133-46(Feb. 1969).

The line spectra of 35 impurities in thoria and zirconia matrices were measured using only the cathode region (0.1 mm beneath the upper electrode) instead of the entire dc arc. It was shown that for uranium this region is very convenient due to its poverty in atomic or ionic line spectra of the matrices and its richness in atomic and ionic lines of the impurities. The method is direct, no carriers are needed, and no chemical or physical separation of the impurities is necessary. Between uranium and zirconium no matrix factor was found, but there was a factor of 1.5 with thorium matrix. Using only one set of impurity standards in U_3O_8, the elements in ZrO_2 and ThO_2 were analyzed with an accuracy of ±15%. The dc arc plasma parameters for thoria and zirconia were measured. (auth) (UK)

21639 DETERMINATION OF URANIUM IN PHOSPHATE ROCKS. Tarantsova, M. I.; Nikolskaya, Ya. P. (Novosibirsk Inst. of Physico-Chemical Treatment of Raw Minerals, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 12, Ser. Khim. Nauk, No. 5, 48-52(Sept. 1968). (In Russian).

The possibility of determining U in phosphate rocks by the perlite luminescence method has been demonstrated. The method involves the preliminary separation of U from other components by precipitation with zirconium phosphate. (tr-auth)

21640 DETERMINATION OF MICROAMOUNTS OF THORIUM IN MAGMATIC ROCKS. Udal'tsova, N. I. Izv. Sib. Otd. Akad. Nauk SSSR, No. 12, Ser. Khim. Nauk, No. 5, 53-6(Sept. 1968). (In Russian).

A photometric method for the determination of microamounts (1×10^{-4} to 1×10^{-6}%) of Th in magmatic rocks is described. The method is based on the separation of Th from impurities by fluoride precipitation followed by sorption from 3.5 M HCl solution on a cation exchange resin and photometric determination using Arsenazo III. (tr-auth)

21641 ARTEFACTS IN THE PAPER CHROMATOGRAPHY OF D-MANNOSAMINE-1-^{14}C HYDROCHLORIDE. Sheppard, G. (Radiochemical Centre, Amersham, Eng.). J. Chromatogr., 40: 312-15(Mar. 25, 1969).

It has been previously noted that certain paper chromatography systems give consistently low apparent radiochemical purities due to heavy streaking of the material on the paper. The streaking and double spotting of D-mannosamine-1-^{14}C hydrochloride (indexed as 2-amino-2-deoxymannose hydrochloride) on paper chromatograms were studied. Purity values were not affected significantly by the use of EDTA in the solvent, by changing the loading of active material, nor by a fourfold diminution in the specific activity of the active material by dilution with carrier D-mannosamine hydrochloride. The streaking was greatly aggravated by the use of acid-washed papers. (J.G.B.)

21642 EFFECTS OF DRYING AND EQUILIBRATION OF PAPER CHROMATOGRAMS OF TRITIUM LABELLED COMPOUNDS. Phillips, R. F.; Waterfield, W. R. (Radiochemical Centre, Amersham, Eng.). J. Chromatogr., 40: 309-11(Mar. 25, 1969).

Aqueous solutions of D-glucose-3-^{3}H and L-leucine-4,5-^{3}H were applied to Whatman No. 1 paper which were then dried with a hot air blower, scanned, developed, and again dried and scanned. Control chromatograms were dried at room temperature. Results indicated that the type of drying after development is the major factor determining the shape of the scan, since solute unequally distributed at the origin is essentially evenly distributed at each surface of the paper after development and remains so provided that uniform drying is applied to the paper. The effects of equilibration on apparent loss of radioactivity were also studied. (J.G.B.)

21643 STUDY OF THE SYSTEM ZIRCONIUM-XYLENOL ORANGE WITH ROTATING PLATINUM ELECTRODES. Tserkovnitskaya, I. A.; Borovaya, N. S.; Ankudinova, M. M. Vestn. Leningrad. Univ., No. 16, Ser. Fiz. Khim., No. 3, 149-54(Aug. 1968). (In Russian).

The determination of zirconium by the amperometric method of titration using Xylenol Orange was studied. The stability of the zirconium complex with Xylenol Orange was evaluated by the amperometric method. (auth)

21644 MIXED OXIDATION-REDUCTION INDICATOR FOR THE REDUCTOMETRIC TITRATION OF MOLYBDENUM. Henze, G.; Geyer, R.; Lahl, W. Neue Huette, 14: 54(Jan. 1969). (In German).

The incorporation of redox indicators for visual indication of the titration end point was tested. The most suitable indicator was found to be a mixture of Safranin T and Ferroin with Sn(II) as titrator. For 5 to 150 mg of Mo, the standard deviation was 0.25 mg. (M.C.G.)

21645 USE OF MORIN IN THE SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM IN PLATINUM. Geissler, Manfred; Lorenz, Gerd; Angermann, Walter (Forschungsinstituts fuer NE-Metalle, Freiberg, Ger.). Neue Huette, 14: 50-2(Jan. 1969). (In German).

A sensitive and largely specific method of analysis is described for determination of 0.2 to 0.001% Zr in Pt−Zr alloys using Morin. The zirconium is separated from platinum by solvent extraction as the Morin complex and measured directly by spectrophotometry. (tr-auth)

21646 METAL CARBIDES. Frad, William A. (Univ. of Missouri, Rolla). Advan. Inorg. Chem. Radiochem., 11: 153-247(1968).

Topics discussed are: general methods of carbide preparation, reactor use of uranium carbides, abrasive or refractory carbides, acetylides, binary carbides of some metals, carbides containing three or more elements, and properties and phase diagrams of carbides. (375 references). (J.G.B.)

21647 TECHNETIUM. Kotegov, K. V.; Pavlov, O. N.; Shvedov, V. P. Advan. Inorg. Chem. Radiochem., 11: 1-90(1968).

The chemical, physical, and nuclear properties of elemental technetium, as well as methods of preparation and properties of technetium compounds, are discussed. Methods of isolating technetium, including dissolution, distillation, precipitation, chromatography, electrochemical and extraction methods, and isotope separations are reviewed. Analytical methods for determining technetium, including radiochemical, gravimetric, colorimetric, spectrophotometric, polarographic, spectral, and other methods, are discussed. The use of technetium as a corrosion inhibitor, a superconductor, in physical investigations, and medicine are also discussed. (273 references). (J.G.B.)

21648 CONTRIBUTIONS TO THE RING OVEN TECHNIQUE. IV. COMPLEXOMETRIC ULTRAMICRO DETERMINATION OF POTASSIUM AND ITS USE FOR DETERMINATION OF THE NATURAL RADIOACTIVITY OF WATER. Gertner, A.; Grdinic, V. (Fakultaet fuer Pharmazie und Biochemie, Zagreb). Mikrochim. Acta, No. 1, 25-9(1969). (In German).

Ultramicro amounts of potassium are separated with the aid of $Na_3Ag[Co(NO_2)_6]$ on the ring furnace in the complexometric determination of potassium. The reaction product is dissolved (with addition of thiocyanate) in hydrochloric acid and the cobalt is titrated with EDTA. The natural radioactivity of the water can be calculated from the equivalent quantity of potassium. (auth)

21649 MOLYBDENUM(VI) HYDROXYLAMINE COMPLEXES. IV. HIGH-SENSITIVITY SPECTRAPHOTOMETRIC DETERMINATION OF MOLYBDENUM AS A TERNARY MOLYBDENUM(VI)-HYDROXYLAMINE-PAR COMPLEX. Lassner, E.; Pueschel, R.; Katzengruber, K.; Schedle, H. (Metallwerk Plansee AG, Reutte, Austria). Mikrochim. Acta, No. 1, 134-44(1969). (In German).

A ternary red complex results from the action of 4-(2-pyridylazo)resorcinol (PAR) with hexavalent molybdenum and hydroxylamine. This product contains the components in a molar ratio 1 : 1 : 1. The formation of this complex is the basis for a very sensitive spectrophotometric determination of molybdenum. The characteristics of this reaction are stated. Interfering foreign ions can be masked by DCTA and tartaric acid or removed by extraction of its PAN-complex with chloroform. Tungsten does not yield a colored complex with PAR. (auth)

21650 A PHOTOMETRIC METHOD FOR DETERMINATION OF VERY SMALL AMOUNTS OF IODINE IN TELLURIUM AND

OTHER MATERIALS. Kujawa, R. (Humboldt-Univ., Berlin). Mikrochim. Acta, No. 1, 193-7(1969). (In German).

The reaction of iodine with mercaptobenzothiazole in the presence of bis-benzothiazolyl-(2)-disulfide and acetonitrile is suitable for the photometric determination of iodine in tellurium and other substances in the ppM range. An extinction coefficient $\epsilon_c = 1.3 \times 10^4$ at 400 nm was calculated for the molecular complex produced. In addition, the formation mechanism of this complex is discussed. (auth)

Isotopic Procedures

Refer also to abstracts 23256 and 23910.

21651 DETERMINATION OF BODY WATER CONTENT USING TRACE LEVELS OF DEUTERIUM OXIDE AND INFRARED SPECTROPHOTOMETRY. Stansell, Marion J.; Mojica, Luis Jr. (School of Aerospace Medicine, Brooks Air Force Base, Tex.). Clin. Chem., 14: 1112-24(Nov. 1968).

A procedure is described for the determination of total-body water content of human subjects using 11- to 12-g doses of D_2O, vacuum sublimation of serum samples, and quantitation of the D by ir spectrophotometry at 2510 cm^{-1}. When D_2O and water are mixed, the following equilibrium occurs: $H_2O + D_2O = 2HOD$. The equilibrium constant for the reaction is 3.80 at 25°C. When the D concentration is less than 3 volumes/100 ml, the solution is comprised essentially of only the 2 molecular species H_2O and HOD. The D_2O concentration, then, of 0 to 1 volumes/100 ml can be assayed adequately by measurements of the O–D fundamental vibration band of HOD at 3.98 μ (2513 cm^{-1}). Since this point is specifically associated with HOD, it is possible to make quantitative measurements of this structure at 2513 cm^{-1} when the HOD is in an aqueous distillate from a more complex system. The coefficient of variation based on day-to-day procedure reproducibility is less than 2%. D_2O added to serum is completely recovered in the sublimation and assay operations. The D_2O dilution procedure compares favorably with the tritium dilution technic, with values obtained on 45 out of 46 individuals falling within the ±3 combined S.D. limits for the 2 methods. The significance of the total-body water data is discussed. (BBB)

21652 DETERMINATION OF THE CONCENTRATION AND ISOTOPIC ABUNDANCES OF AMERICIUM AND CURIUM. Koch, L.; Geerlings, M. W. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 11: 49-51(Mar. 1969). (In German).

A method is given for the simultaneous determination of americium and curium isotopic abundances by mass spectrometry. The concentration of the elements is determined by isotope dilution analysis (for americium by mass spectrometry and for curium by α-spectrometry). No separation of americium and curium is needed. (auth)

21653 DENSIMETRIC ISOTOPIC ANALYSIS OF LIGHT AND HEAVY WATER BY USE OF OXYGEN EXCHANGE BETWEEN CARBON DIOXIDE AND WATER. Staschewski, Dieter (Kernforschungszentrums, Karlsruhe, Ger.). Ber. Bunsenges. Phys. Chem., 73: No. 1, 59-65(Mar. 1969). (In German).

For the determination of the D_2O content of water samples using the float method, the composition of the oxygen isotopes in water is normalized by isotope exchange with natural carbon dioxide. The exchange reaction between gaseous CO_2 and water, catalyzed by $KHCO_3$ and $KDCO_3$, causes an exponential decrease of the excess concentration of ^{18}O and ^{17}O. The equilibrium concentrations of the heavy oxygen isotopes were determined at optimal experimental conditions taking into account the separation effects for D/H, $^{18}O/^{16}O$, and $^{17}O/^{16}O$. For the calibration of the D_2O floats, normalized 100% D_2O standards are used, which are prepared electrolytically. For a series of H_2O and D_2O samples the oxygen composition is determined densimetrically as well as mass spectrometrically. (auth)

21654 USE OF RADIOACTIVELY LABELED SILVER TO DETERMINE METALS IN MICRO- AND SUBMICROGRAM AMOUNTS. Krivan, V.; Weisz, H. (Univ., Freiburg i. B.). Mikrochim. Acta, No. 1, 84-90(1969). (In German).

The use of radioactive labeled silver (^{110m}Ag) as a universal radio reagent is described for determining several metals in micro- and submicro amounts. The metal to be determined is precipitated as sulfide on filter paper, converted into an equivalent amount of silver sulfide, whose ^{110m}Ag-activity is measured and compared with that of a standard prepared in the same way. It is also possible to determine several different metals employing only a single standard (for instance Zn) provided the equivalent weights of the metal to be determined and that of the metal serving as standard are taken into account. Cu, Pb, Cd, As, Co, and Zn were determined in this manner in amounts from 0.05 to 2 μg with excellent reproducibility. (auth)

Radiometric Procedures

Refer also to abstracts 21841 and 22113.

21655 (SZS-1/69) DETERMINATION OF THE BETA RADIOACTIVITY IN WATER WITH COMMERCIALLY AVAILABLE DETECTORS (VA-Z-310, VA-Z-530, VA-T-84) FROM THE VIEWPOINT OF RADIATION PROTECTION. Stange, E. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Jan. 1969. 34p. (In German). Dep.

The technical problems associated with radiological measurements of β activity in water samples as well as the necessary corrections of the counting rate due to energy dependency are outlined (corresponding diagrams are given). The detectors VA-Z-310 (Geiger-Mueller counter), VA-Z-530 (gas-flow proportional counter), and VA-T-84 (scintillation counter) were examined with regard to their applicability to radioactivity control measurements in water. For the detectors VA-Z-310 and VA-T-84 simple methods are described for determination of the mean maximum β energy, using a special absorber and the method of discrimination, respectively. (auth)

21656 RADIOMETRICHESKOE OPREDELENIE SERY. (Radiometric Determination of Sulfur). Lyast, I. Ts.; Drobiz, A. M.; Khachaturov, Yu. G. Moscow, Izdatel'stvo Khimiya, 1968. 80p.

A method for radiometric determination of sulfur in liquids and gases under laboratory and industrial conditions was developed. The physical basis of the method along with properties of gamma radiation are discussed. Errors and limitations of the method are examined in relation to the properties of the source of radiation. Methods for reduction of errors are indicated. Procedures and equipment are described. Data obtained by this method are briefly surveyed. (tr-auth)

21657 PROTON MICROANALYSIS. Price, P. B. (Univ. of New South Wales, Kensington); Bird, J. R. Nucl. Instrum. Methods, 69: 277-81(Apr. 1969).

Oxygen concentrations were measured by the detection of alpha particles from the $^{18}O(p,\alpha)^{15}N$ reaction. A proton beam of size 0.002 inch was shown to allow microanalysis with a spatial resolution equal to the beam size. Investigation of possible sources of error in this technique show that it is both accurate and reproducible.

21658 METHOD FOR THE THIN-LAYER RADIOCHROMATOGRAPHIC ANALYSIS OF TRITIUM AND ^{14}C WITH USE OF THE GAS FLOW-THROUGH TUBE VA-Z-530. Rabitzsch, G. Monatsber. Deut. Akad. Wiss. Berlin, 10: 781-90(1968). (In German).

By use of radio thin-layer chromatograms, which are characterized by their simple structure with consideration of essentially functional hypotheses and by an extensive introduction of commercial supply and registration units, investigations on the effect of various chromatographic and measurement factors on the efficiency and reproducibility of a quantitative radio thin-layer chromatographic measurement of tritium and ^{14}C are reported. With a detection limit of 2 nCi ^{3}H and 0.1 nCi ^{14}C, the measurement efficiency is 1.5 and 23.5%, respectively. The total error is between 10 and 20% according to the activity level. (tr-auth)

21659 PREPARATION OF LIQUID SCINTILLATION MIXTURES FOR THE MEASUREMENT OF ^{14}C AND ^{3}H SAMPLES. Roberts, W. A. (Beckman Instruments Ltd., Fife, Scotland). Lab. Pract., 17: 703-6(June 1968).

Selection of suitable materials for liquid scintillation is described. Mixtures for measurement of a wide range of ^{14}C- and tritium-labeled samples are given. Included are samples soluble in organic solvents, samples soluble in aqueous solution, and those which are insoluble. Biological materials often produce deeply colored samples, the color causing considerable quenching by simple absorption of the emitted light, while attempts to bleach the solution can result in further degradation or heavier chemical quenching. The most efficient preparation technique is combustion and oxidation, leading to collection of the tritium as water and the ^{14}C as carbon dioxide. References to practical methods are given. (BBB)

21660 INDIRECT DETERMINATIONS BY THE METHOD OF THE BACKSCATTERING OF β^- RAYS. I. DETERMINATION OF SODIUM. Marcu, Gh.; Sacelean, V. (Institut de Chimie de l'Academie, Cluj). Rev. Roum. Chim., 13: 1463-7(Nov. 1968). (In French).

A new indirect method for the radiometric determination of sodium, based on the relation between the concentration of a solution and the intensity of the backscattered β^- rays, is proposed. A solution containing sodium to be determined is introduced into a solution containing Zn^{2+} and UO_2^{2+} ions. After precipitation of the compound $NaZn[UO_2(CH_3COO)_3]_3 \cdot 6H_2O$ the backscattering capacity of the solution decreases in direct proportion to the ions eliminated by precipitation and so with the sodium introduced. The method is useful for analyses in the sodium series. (tr-auth)

21661 A METHOD FOR DETERMINING THE RADIOCHEMICAL PURITY OF STEROIDS. **Wang, D. Y.; Bulbrook, R. D. (Imperial Cancer Research Fund, London). J. Endocrinol., 42: 159-60(Sept. 1968).**

The specific binding of some steroids to proteins may be exploited as an additional parameter in establishing the radiochemical purity of radioactive metabolites. This possibility was tested using testosterone as a model compound. A mixture of pregnancy plasma and 0.05M borate buffer was added to 7-^{3}H-testosterone and 4-^{14}C-testosterone and shaken for 10 min. To duplicate tubes, containing increasing amounts of carrier testosterone, was added 1 ml of the radioactive plasma solution and the tubes were shaken for 15 min then dextran-coated charcoal suspension in water was added to absorb the unbound steroid. The supernatant was extracted with dichloromethane, the extract dried, and the residue dissolved in toluene-based phosphor for liquid scintillation determination of ratio of ^{3}H to ^{14}C. The effects of adding 5 to 10% (with respect to tritium) of tritiated steroids other than testosterone, are shown. Two extreme cases were noted: one in which the impurity was strongly bound to the protein and the other in which the impurity was not bound at all. The presence of a radioactive impurity in the samples was detectable by a change in the ^{3}H : ^{14}C ratio either on treatment with charcoal and binding protein, or when carrier testosterone was added to the system. This simple and quick technique adds a further parameter for the characterization of radioactive steroids. (BBB)

Activation Procedures

21662 (BNL-13133) HIGH RESOLUTION GAMMA RAY SPECTROSCOPIC ANALYSES OF MAYAN FINE ORANGE POTTERY WITH BRIEF COMMENTS ON THEIR ARCHAEOLOGICAL BACKGROUND AND IMPLICATIONS. Sayre, Edward V.; Chan, Lui-Heung; Sabloff, Jeremy A. (Brookhaven National Lab., Upton, N. Y. Harvard Univ., Boston, Mass.). [1968]. 64p. (CONF-680918-6). Dep. CFSTI.

From American Chemical Society Meeting, Atlantic City, N. J.

Slices of the firm interior portions of the pottery sherds were used as samples for activation analysis. Trace elements were determined and statistical summaries showed that concentrations of several elements in this fine ware from site to site are consistent with a standard deviation of about 10%. (M.C.G.)

21663 (BNL-13134) COMPOSITIONAL CATEGORIES OF SOME ENGLISH AND AMERICAN POTTERY OF THE AMERICAN COLONIAL PERIOD. Olin, Jacqueline S.; Sayre, Edward V. (Brookhaven National Lab., Upton, N. Y.). [1968]. 45p. (CONF-680918-5). Dep. CFSTI.

From American Chemical Society Meeting, Atlantic City, N. J.

Neutron activation analysis was used to compare the compositional categories of some English and American pottery of the Americal Colonial period. Small plates cut from the interior of the pottery specimens were leached overnight in distilled water, dried, wrapped in aluminum foil and exposed to a flux of neutrons, 1.0×10^{13} n/cm^2 sec for 24 hrs. The induced activities were counted by lithium-drifted germanium detectors. (M.C.G.)

21664 (CEA-CONF-1254) ACTIVATION ANALYSIS IN PLANT BIOLOGY. RADIOECOLOGICAL APPLICATIONS USING SIMPLE OR AUTOMATED RADIOCHEMICAL SEPARATION TECHNIQUES. Fourcy, A.; Neuburger, M.; Garrec, C.; Fer, A.; Garrec, J. P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1967]. 19p. (CONF-681003-12). Dep.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md.

It is shown that activation analysis is a very sensitive method for radioecology, and permits determination of stable elements in the environment corresponding to radionuclides from radioactive wastes. The first step in attempting a larger use of the method is automation of the radiochemical processes in the method. (auth)

21665 (CONF-670649-30) DETERMINATION OF RHENIUM BY NEUTRON ACTIVATION IN SEDIMENTARY ROCKS. **Martin, A.; Albisu, F. (Escuela Tecnica Superior de Ingenieros Industriales, Bilbao (Spain). Laboratorios de Ensayos e Investigacion Industrial); Elejalde, C. (Escuela Tecnica Superior de Ingenieros Industriales, Bilbao (Spain)). [1966]. 9p. (In Spanish). Dep.**

From Symposium on Applications of Radioisotopes, Madrid, Spain.

A method for the neutron-activation determination of Re in sedimentary rocks in the presence of U and Mo is presented. The samples were irradiated in a thermal flux of approximately 2×10^{10} n/cm^{2}sec for 1 to 2 hrs. The radiochemical separation of Re was based on chloroform extraction of tetraphenylarsonium perrhenate at pH 8 to 10 in the presence of an excess of the reagent, after dissolution of the sample. Various methods are proposed for dissolution of the sample according to the carbon content of the sample. The Re is determined by γ spectrometry with a scintillation detector. (J.S.R.)

21666 (CONF-670649-38) RECENT APPLICATIONS OF ACTIVATION ANALYSIS IN THE JUNTA DE ENERGIA NUCLEAR. **Travesi, A. (Junta de Energia Nuclear, Madrid (Spain)). [1967]. 19p. (In Spanish). Dep.**

From Symposium on Applications of Radioisotopes, Madrid, Spain.

The principal applications of neutron activation analysis, developed in the Junta de Energia Nuclear during the last three years, are described. These applications were in diverse fields such as control of industrial processes, analysis of minerals and rocks, biological applications, applications in criminal investigations, and use of tracers that can be activated. The analytical methods developed for a wide variety of trace elements are described briefly. A description is given of the basic principles of activation analysis and the methods and equipment available in the JEN for their practical realization. The analytical sensitivities of a series of elements, under actual conditions available at the JEN with different types of irradiations normalized to the irradiation devices of the JEN-1 reactor, are tabulated. (tr-auth)

21667 (CONF-681003-11) ACTIVATION ANALYSIS APPLIED TO SEDIMENTS FROM VARIOUS RIVER DELTAS. de Groot, A. J.; Zschuppe, K. H.; de Bruin, M.; Houtman, J. P. W.; Singgih, P. Amin (Reactor Instituut, Delft (Netherlands)). [nd]. 17p. (RI-133-68-8). Dep.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md.

Nondestructive neutron activation analysis was used to determine trace elements in various river deltas. Results of analyses for Mn, Sm, La, Zn, As, Sc, Cr, Cu, and Co are presented. (M.C.G.)

21668 (NP-tr-1747) NEUTRON COUNTING AND BORON DETERMINATION BY DETECTION OF DE-EXCITATION GAMMA FROM THE ^{7}Li* NUCLEUS PRODUCED BY THE REACTION ^{10}B(n,α)^{7}Li*. Laune, J. Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from J. Phys. Radium, 23: 238-40(1962). 6p. Dep

An abstract of this paper, prepared from the original language, appeared as NSA 16: 28063. (TSS)

21669 DETERMINATION OF VERY SMALL AMOUNTS OF SCANDIUM AND COBALT IN S.R. GRADE BERYLLIUM BY NEUTRON ACTIVATION AND GAMMA SPECTROSCOPY. Dugain, F. (Laboratoire de Recherches d'Electrochimie et des Metaux Nouveaux, Grenoble, France). Met. Soc. Conf., 34: Pt. 1, 129-38 (1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

Activation analysis, including radiochemical separations, was found to be suitable for the accurate determination of such small amounts as 10^{-10} g of scandium and 10^{-9} g of cobalt using 2×10^{12} n $\cdot$ cm^{-2} s^{-1} irradiation flux for 120 hours. The procedure was adapted to the analysis of several beryllium compounds, and more than 70 samples were analyzed in this way. (auth)

21670 GAMMA-ACTIVATION METHOD FOR DETERMINING RHODIUM. **Kodiri, S.; Deev, Yu. S. (Tadzhik State Univ., Stalinabad, USSR). Dokl. Akad. Nauk Tadz. SSR, 11: No. 12, 19-21(1968). (In Russian).**

Determination of rhodium by the ^{103}Rh(γ,γ')^{103m}Rh reaction using bremsstrahlung from a linear accelerator is described. Radiation appearing due to the transition of ^{103}Rh from the metastable state to the ground state was recorded using a NaI(Tl) scintillation spectrometer and a 100-channel pulse analyzer. The gamma energy for decaying ^{103m}Rh was 20.5 ± 2 keV. (R.V.J.)

21671 γ-PHOTON ACTIVATION FOR A NONDESTRUCTIVE DETERMINATION OF SMALL QUANTITIES OF OXYGEN IN VERY PURE SODIUM. **Engelmann, Charles; Loeuillet, Monique (CEN, Saclay, France). Bull. Soc. Chim. Fr., No. 2, 680-3(Feb. 1969). (In French).**

A new method for determining oxygen in sodium is described. The conditions for which this nondestructive method is applicable are discussed. Principally they concern: the maximum irradiation energy which should not be exceeded because of the formation of ^{18}F by the reaction ^{23}Na(γ,αn)^{18}F, the specific activity of which increases very rapidly with energy, and the maximum permissible levels for the other impurities, in particular potassium. Experi-

ments show that it is possible to determine oxygen content of 2 to 5 ppM, in a sample containing a few ppM of potassium. This sensitivity may be improved by a factor of at least 5 by using special counting devices. (auth)

21672 ACTIVATION ANALYSIS OF NORMAL AND ATHEROSCLEROTIC AORTAS. Strain, W. H.; Rob, C. G.; Pories, W. J.; Childers, R. C.; Thompson, M. F. Jr.; Hennessen, J. A.; Graber, F. M. (Univ. of Rochester, N. Y. Wright-Patterson AFB, Ohio. Gulf General Atomic, San Diego, Calif.). Appl. Spectrosc., 23: 121-4(Mar.-Apr. 1969).

Normal and atherosclerotic aortas from rats and man were analyzed by neutron activation to determine changes in the content of Ca, Cd, Co, Cu, Mg, Mn, Se, V, and Zn with the development of degenerative changes. Samples of aortic tissue were weighed, dried at 110°C overnight, and irradiated for 30 min in a thermal neutron flux of 1.8×10^{12} n/cm^2-sec in a TRIGA Mark I reactor. Immediately after irradiation, the samples were wet-ashed in the presence of carriers, the various elements were then radiochemically separated, and the separated fractions were counted by multichannel gamma-ray spectrometry. Definite values, or firm upper limits, for the elements were calculated by computer. With increasing degree of atherosclerosis, the Ca content rose from <350 to 36,000 ± 2,000 ppM; Co from undetectable to 0.34 ppM; Mg from <110 to 880 ppM; Mn from 0.34 to 1.26 ppM; and Zn from 37 to 152 ppM. Significant changes could not be detected in Cd, Se, and V; changes in Cu were not consistent. These results are discussed in relation to the pathological changes and to zinc therapy in the treatment of atherosclerosis. (auth)

21673 THE ABUNDANCES OF ARSENIC, TIN, AND ANTIMONY IN CHONDRITIC METEORITES. Hamaguchi, H.; Onuma, N.; Hirao, Y.; Yokoyama, H.; Bando, S.; Furukawa, M. (Tokyo Univ.). Geochim. Cosmochim. Acta, 33: 507-18(Apr. 1969).

Abundances of arsenic, tin, and antimony in various classes of chondritic meteorites were determined by neutron activation analysis. A simultaneous analytical procedure for As, Sn, and Sb was developed using anion-exchange chromatography in ammonium thiocyanate—hydrochloric acid media and was applied to the determination of these elements in a number of carbonaceous, enstatite, and "ordinary" chondrites. The results indicate that these elements are inhomogeneously distributed in some carbonaceous (Type I, II, and III) and enstatite (Type A) chondrites. The average atomic abundances ($Si = 10^6$) of these elements are given. The observed atomic chondritic abundances are compared with the "cosmic" abundances in the odd-mass regions 63 to 81 and 105 to 127. (auth) (UK)

21674 Hf DETERMINATION IN A ZIRCONIUM MATRIX BY LIFE TIME MEASUREMENTS OF THE 15ns ^{181}Ta EXCITED STATE. Herr, W.; Herpers, U.; Hess, B. (Univ., Cologne). Radiochim. Acta, 11: 61-2(Mar. 1969).

The use of the 0.482-MeV excited state of ^{181}Ta with a very short lifetime (about 15 ns) for the determination of Hf in a Zr matrix is reported. Such measurements can be simply achieved by using a conventional "fast-slow" arrangement for lifetime determinations. The "lifetime method" gives quite reliable results as demonstrated by comparing the data from the determination of Hf in Zircaloy by the time spectrum ^{181}Hf—^{181}Ta level 0.482 MeV with those obtained by normal γ spectrometry using Ge(Li) detector ^{181}Hf 0.482/^{95}Zr 0.724. (D.H.M.)

21675 PHOTON ACTIVATION ANALYSIS OF IRON METEORITES. I. Meijers, P.; Aten, A. H. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta, 11: 60(Mar. 1969).

The main constituents (Fe, Ni, and Co) of iron meteorites were determined by activation by bremsstrahlung produced in the bombardment of a tantalum target of 2-mm thickness with 23-MeV electrons. Pieces of the meteorite material were irradiated between discs of a standard Fe—Ni—Co alloy as were discs of each of the three pure metals. The 0.511-MeV annihilation radiation was measured with a NaI-crystal detector combined with a single channel analyzer. The ^{53}Fe activity was measured during the first two hours after irradiation, the ^{57}Ni after about two days, and the ^{58}Co after about three weeks. The decay curve of the annihilation radiation was analyzed into its three components. One or both of the standard alloy discs were measured in the same way during the same period. (D.H.M.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 21646, 21647, 21653, 21732, 21737, 22482, 22678, and 24056.

21676 (AI-AEC–12744, pp 131-8) SODIUM CHEMISTRY, FUNDAMENTAL STUDIES. McKisson, R. L.; Eichelberger, R. L.; Gehri, D. C.; Guon, J. (Atomics International, Canoga Park, Calif.).

Progress on the study of the chemistry of liquid sodium as a solvent for metals and nonmetals and completion of the Sodium Chemistry Loop are reported. The equation for the solubility of C in Na as reported in AI-AEC-12721, was modified as a result of additional experiments at 700 and 900°C. Using data from all experiments a ΔH(soln) of 1700 cal/mole was calculated. Results of metals-in-sodium solubility studies are reported for Cr, Fe, Nb, and Bi. Improvements were made on the Spark Source Mass Spectrometer. (D.H.M.)

21677 (AI-AEC–12744, pp 153-7) HIGH TEMPERATURE CHEMISTRY. (Atomics International, Canoga Park, Calif.).

Progress is reported in the study of fused salts and of metal—metal—salt solutions. The electric conductivities of the molten $CuCl-CuCl_2$ system was measured and electron exchange was established as the most likely mechanism of electronic conductivity. A study of the electric conductivities of $AlCl_3-KCl$ and $AlBr_3-NaBr$ is reported. The conductivity of a fused silica cell containing CsCl and LiCl vapor was measured using platinum foil electrodes. Conductivity measurements on single crystal CaF_2 samples at temperatures from 500 to 750°C with various electrodes indicate that impurities are reacting with the samples. A theoretical study of ternary salt systems was initiated and a review of some of the concepts important in molten salt chemistry was completed at North American Rockwell Science Center. (D.H.M.)

21678 (BMwF-FBK–68-42) ON THE VAPOR PHASE HYDROLYSIS OF SOME LANTHANIDE(III) CHLORIDES. Wishnevsky, V. (Munich Univ. (West Germany). Institut fuer Anorganische Chemie). Sept. 1968. 121p. (In German). Dep.

By means of a micromethod, the equilibrium constant K_p of the following reaction: $MCl_3 + H_2O \rightarrow MOCl + 2HCl$ where M = Y, Dy, Er, Tm, and Pm, was measured as a function of temperature. From the measured data, the free energy ΔG°_T of this reaction was obtained. Adaptation of experimental ΔG°_T values to a semi-empirical ΔG°_T function yielded numerical values for the following thermodynamic parameters: ΔH_{298}, ΔH_{785}, ΔS_{298}, ΔS_{785}. From these data, the following numerical values for the heats of formation of oxychlorides MOCl (ΔH°_{298}) were calculated (in kcal/mole): YOCl: −234.4; DyOCl: −234.4 and −234.7; ErOCl: −231.2; TmOCl: −229.1; and PmOCl: −245.3. In the case of dysprosium, two different sets of K_p-values were found. They may be explained by the existence of two polymorphs of dysprosium(III) chloride, β-$DyCl_3$ and γ-$DyCl_3$, which differ in their heats of formation by 2.6 kcal mole. Adaptation of the method to the measurement of parameters of highly radioactive materials is described for M = Pm. (auth)

21679 (CONF-680821–, pp 342-53) EVIDENCE FOR THE EXISTENCE OF HYPOIODOUS ACID AS A VOLATILE IODINE SPECIES PRODUCED IN WAER-AIR MIXTURES. Cartan, F. O.; Beard, H. R.; Duce, F. A.; Keller, J. H. (Idaho Nuclear Corp., Idaho Falls).

A large amount of a nonelemental iodine species was observed in an experiment in which carrier-free ^{131}I was introduced into a steam-air filled 86-ft^3 containment vessel. Gas chromatographic analyses and the distribution of iodine on sampler components show that the species was not methyl or ethyl iodide. A review of the properties of possible iodine compounds suggested that the species was hypoiodous acid, HOI. A volatile nonelemental species of iodine, like that observed in the large scale test, was generated in the laboratory by hydrolysis of iodine. Its volatility, limited stability, and the conditions of generation indicate that it is hypoiodous acid. 13 references. (auth)

21680 (NIJS-P–227) ON THE SYNTHESIS AND PROPERTIES OF HYDRAZINIUM (1+) FLUORIDE. Glavic, Peter (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Sept. 1968. 57p. (In Slovenian). Dep.

Thesis. Submitted to Univ. of Ljubljana, Yugoslavia.

Pure hydrazinium (1+) fluoride was prepared by dissolution of hydrazinium (2+) fluoride in anhydrous hydrazine and by subsequent crystallization from the hot, saturated solution. The crystals are orthorombic with a = 4.592, b = 8.217, and c = 12.341 Å, the space group is $P2_12_12_1$ with eight molecules per unit cell. The hydrogen bonding in this compound is stronger than in the corresponding chloride. This additional strength was attributed to stronger N—H—F bonds. The salt is diamagnetic ($\chi_m = -30.2 \times 10^{-6}$ cgs units). It is very soluble in water, slightly soluble in anhydrous hydrazine, methanol, and ethanol, but insoluble in nonpolar solvents. Hydrazinium (1+) fluoride decomposes above 80°C, giving hydrazinium (2+) fluoride and hydrazine. The heats of solution of hydrazine (1+) fluoride in water and in anhydrous hydrazine as well as the heat of neutralization of hydrazine and hydrofluoric acid are given. The ionic species present in dilute aqueous solutions, containing hydrazinium (1+) fluoride, were studied. To illustrate some of the chemical properties of hydrazinium (1+) fluoride, the systems $UF_4-N_2H_5F-H_2O$ and $UF_4-N_2H_5F-N_2H_4$ were investigated. Complex fluorides with formulas $(N_2H_5)_2UF_6$ and $(N_2H_5)_3UF_7$ were isolated. The absorption spectra of uranium tetrafluoride and hydrazinium (1+) fluoride solutions in water and in anhydrous hydrazine show that the formation of UF_6^{2-} and UF_8^{4-} species in such solutions depends on the fluoride ion concentration. The solubility of uranium(IV) in these two systems is much higher than the solubility of uranium(IV) in the $UF_4-NH_4F-H_2O$ system, reaching 8.15 wt. % in water solutions and 22.7 wt. % in anhydrous hydrazine. A N_2H_5F deficient compound 11 $N_2H_5F \cdot 6\ UF_4$ may be precipitated from highly concentrated aqueous solutions, containing uranium tetrafluoride and hydrazinium (1+) fluoride, by diluting them with water. Infrared and visible spectra of the compounds as well as x-ray powder data were recorded. The thermal decomposition of the complexes is discussed. (auth)

21681 (ORO-3345-4) CHEMICAL STRUCTURAL STUDIES BY NUCLEAR TECHNIQUES AND NUCLEAR FISSION SYSTEMATICS. Yearly Progress Report, March 1, 1968–February 28, 1969. Ellis, William H.; Ortabasi, Ugur; Nair, Kesi (Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences). Mar. 1, 1969. Contract AT(40-1)-3345. 114p. Dep. CFSTI.

Research activities undertaken with time-dependent angular correlation (TDAC) measurements associated with the study of chemical structure by nuclear techniques are described. The TDAC measurements demonstrated that static field hyperfine quadrupole interaction effects can be observed for rare earth ions in polycrystalline environments and that time-dependent perturbed angular correlation (TDPAC) measurements are practical with ^{169}Tm gamma cascades. A distinct cycle behavior was observed for the single-angle time dependent coincidence spectra and the time dependence of anisotropy. Results of this nature were obtained for ytterbium crystal hydrates. Investigations were also made of the effect of a nonuniform nuclear charge distribution on fission fragment mass asymmetry. An analytical model was developed for describing the dynamic interrelationship of factors determining the total energy of a deforming nucleus represented as a charged liquid drop having nonuniform charge density. Saddle point configurations are being determined as a function of the charge asymmetry and fission fragment mass ratios. (M.C.G.)

21682 (RFP-1317) A FORTRAN IV PROGRAM FOR COMPUTING THE STICKING PROBABILITY OF GASES ON SOLID SURFACES. Loser, Robert W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Mar. 19, 1969. Contract AT(29-1)-1106. 22p. Dep. CFSTI.

A FORTRAN IV program is presented, which computes the sticking probability of various gases on solid surfaces. Sticking probability is defined as the ratio of the number of molecules of gas sticking to a substrate to the number of molecules of gas striking the substrate. The program was written specifically for the chemisorption of various gases on plutonium. A brief description of the experimental method is presented along with a complete description of the required input data and the resulting output data. The entire numerical approach used in computing sticking probability is presented, the key equations used and the FORTRAN IV program are described. (auth)

21683 DIFFRACTION AND SPECTROSCOPIC STUDIES OF THE COBALTIC ACID SYSTEM $HCoO_2$–$DCoO_2$. Delaplane, Robert G. (Northwestern Univ., Evanston, Ill.); Ibers, James A.; Ferraro, John R.; Rush, John J. J. Chem. Phys., 50: 1920-7(Mar. 1, 1969).

Cobaltic acid, $HCoO_2$, and deuterated cobaltic acid, $DCoO_2$, have been prepared and studied by x-ray and neutron-diffraction techniques, and by infrared spectroscopy and cold-neutron scattering. The materials crystallize in apparent space group D_{3d}^5-$R\bar{3}m$ of the trigonal system with three molecules in a hexagonal cell of dimensions: $HCoO_2$, a = 2.851(1), c = 13.150(5) Å; $DCoO_2$, a = 2.854(1), c = 13.354(5) Å. The O–O distance, as determined by neutron-powder studies, of $HCoO_2$ is 2.50(2) Å. On this basis and the fact that there are three O–H–O bonds along the c direction, the O–D–O distance is 2.57(2) Å. Hence, the isotope effect here is as large as in the system $HCrO_2-DCrO_2$. Infrared studies at room temperature and at −195°C over the region 70–4000 cm^{-1} may be interpreted in terms of an effectively symmetric O–H–O bond and an effectively asymmetric O–D–O bond. Although the neutron inelastic scattering measurements are not inconsistent with this interpretation, there is a band centered at 264 cm^{-1} in the neutron spectrum for $HCoO_2$, which is not observed in the infrared spectrum. Model calculations, based on a two-dimensional potential function in which the asymmetric stretching frequency is coupled to the symmetric stretching frequency, were unsuccessful owing to the magnitude of the coupling term required to account for the very large isotope effect. (auth)

21684 RAMAN AND INFRARED SPECTROSCOPIC STUDIES OF THE URANYL ION: THE SYMMETRIC STRETCHING FREQUENCY, FORCE CONSTANTS, AND BOND LENGTHS. Bullock, J. I. (Univ. of Surrey, London). J. Chem. Soc., A, No. 5, 781-4(1969).

The symmetric stretching frequency of the uranyl ion was measured for some uranyl compounds with the use of Raman excitation. The symmetric and asymmetric stretching frequencies were used in the calculation of stretching and interaction force constants, from which was derived an estimate of the uranium–oxygen bond lengths by use of Badger's rule. These bond lengths are in good agreement with the few crystallographic data available. Previous calculations of force constants ignored interaction constants, and bond-length determinations relied upon an estimate of the bending frequency of the uranyl ion or upon force constants derived from the asymmetric stretching frequency only. The present measurements confirm that the uranyl ion is linear, or very nearly so. The overtone and combination bands of some uranyl nitrate complexes were re-investigated. (auth) (UK)

21685 KINETICS OF THE REDUCTION OF PLUTONIUM(VI) BY NITROUS ACID TO THE PENTAVALENT STATE. Koltunov, V. S.; Zhuravleva, G. I. Radiokhimiya, 10: 662-9(1968). (In Russian).

Kinetics and equilibrium of the reduction reaction for Pu^{6+} to Pu^{5+} by nitrous acid at 20°C were studied. The rate of the reaction was directly proportional to the concentration of Pu^{6+} and HNO_2 and inversely proportional to the concentration of H^+ ions. Kinetic equations were developed and mechanisms are discussed. (tr-auth)

21686 PRODUCTION AND CERTAIN PROPERTIES OF THE SLIGHTLY SOLUBLE COMPOUNDS OF Pu(V). Zaitseva, V. P.; Alekseeva, D. P.; Gel'man, A. D. Radiokhimiya, 10: 669-76 (1968). (In Russian).

A carbonate compound of Pu^{5+} was prepared and on the basis of chemical analysis its formula is proposed to be $NH_4PuO_2CO_3 \cdot 3H_2O$. It was established that in dilute CO_3^{2-} solutions formation of $(NH_4)_2PuO_2CO_3OH \cdot nH_2O$ also occurs. The solubility of $NH_4PuO_2CO_3 \cdot nH_2O$ in carbonate solutions was determined. The increase in concentration of CO_3^{2-} ions in solution (~ to 15%) led to the suppression of the hydrolysis of plutonyl carbonates. A fluoride compound of Pu^{5+} was prepared and its formula was calculated to be $NH_4PuO_2F_2$. On dissolution of plutonyl difluoride in water the transition of Pu^{5+} to Pu^{6+} was observed. It was established that with HPO_4^{2-} ions Pu^{5+} forms a slightly soluble compound, the formula of which is $NH_4PuO_2HPO_4 \cdot 4H_2O$. (tr-auth)

21687 THE APPLICATION OF ALKYLAMMONIUM SALTS TO THE DISSOLUTION OF INORGANIC COMPOUNDS. II. DISSOLUTION OF $U(C_2O_4)_2.6H_2O$ IN SOLUTIONS OF TRIOCTYLAMMONIUM OXALATE. Lipovskii, A. A.; Kuzina, M. G. Radiokhimiya, 10: 676-80(1968). (In Russian).

Dioxalates of tetravalent uranium showed that slightly soluble salts, in which the central atom of the metal is coordinationaly unsaturated in relation to the acid ligands, can be transferred into solution with complex formation in a heterogeneous system, which provides an increase in the stability of the complex compounds formed. The compositions of compounds formed on dissolution of the hexahydrate of uranium dioxalate in a solution of trioctylammonium oxalate in benzene were established. The conditions for extraction of uranium from the organic phase were determined. Re-extraction by solutions of acids leads to the decomposition of the complex compound and to the formation of a uranium dioxalate precipitate. (tr-auth)

21688 PRECIPITATION OF COMPOUNDS OF URANIUM ON METALS BY THE CONTACT METHOD. Surin, V. M.; Khlebnikov, G. I. Radiokhimiya, 10: 680-7(1968). (In Russian).

The influence of concentrations of solutions of uranyl nitrate (5.0 to 20.0 g/l), temperature (25 to 100°C), time of contact (up to 120 min), acidity of the solution (in the pH range from 1.2 to 5.1), and additions of NH_4NO_3 and $Al(NO_3)_3$ on the precipitation of compounds of uranium on aluminum by the contact method was studied. The amount of uranium precipitated was proportional to the concentration of the solution, temperature, and time of contact of the aluminum by solutions of uranyl nitrate. The relation of the amount of uranium in the precipitate to the acidity of the environment was complex; in the region of pH = 2.7 to 3.2 the rate of precipitation of uranium was at a maximum and in more or less acid solutions it decreased. Additions of NH_4NO_3 and $Al(NO_3)_3$ inhibited the transition of uranium from solution to precipitate. The structure of the uranium layers on aluminum was studied by roentgenographic and optical methods. The material in the layers was mainly UO_2. A probable mechanism of contact precipitation of uranium on aluminum is proposed. A formula was developed for estimating the amount of elemental uranium in the layers on aluminum that is correct for the following conditions: uranyl nitrate concentrations of 5 to 20 g/l, a temperature of 75 to 95°C, and a pH of 2.0 to 3.0. (tr-auth)

21689 THE SYSTEM URANYL SULPHATE–WATER. I. PREPARATION AND CHARACTERIZATION OF THE PHASES IN THE SYSTEM. Cordfunke, E. H. P. (Reactor Centrum Nederland, Petten). J. Inorg. Nucl. Chem., 31: 1327-35(May 1969).

In the system uranyl sulphate–water only one stable hydrate, $UO_2SO_4 \cdot 2.5H_2O$, was found between room temperature and 100°C. The thermal stability of this hydrate was examined. The monohydrate, $UO_2SO_4 \cdot H_2O$, can only be prepared at temperatures of about 200°C and under special conditions. From a study of the ternary system $UO_2SO_4-H_2SO_4-H_2O$, the existence of a metastable hydrate $UO_2SO_4 \cdot 2H_2O$ and an acid salt $UO_2SO_4 \cdot H_2SO_4 \cdot 2.5H_2O$ was indicated. (auth) (UK)

21690 VLIYANIE IZOTOPII NA FIZIKO-KHIMICHESKIE SVOISTVA ZHIDKOSTEI. (Effects of Isotopes on Physical-Chemical Properties of Liquids). Rabinovich, I. B. Moscow, Izdatel'stvo Nauka, 1968. 308p.

The effects of the substitution of one isotope for another isotope on the different physicochemical properties of liquids are discussed. The literature was examined and generalized experimental and theoretical date concerning isotope effects are presented. Various isotope effects on vapor pressure, on which the separation of isotopes by fractionation is based, are discussed. The effects of isotopic substitution on molar volume, refraction, polarizability of molecules, critical temperature, heat capacity, sound velocity, compressibility, viscosity, surface tension, solubility, and thermodynamic properties of solutions and their components are examined. Properties of isotopic varieties of helium, neon, argon, hydrogen, nitrogen, oxygen, numerous inorganic and organic compounds, and various ligands with hydrogen bonds are described. In particular, the properties of oxides of hydrogen, deuterium, and tritium with normal and heavy oxygen are considered. The theory of the influence of isotopes on Van-der-Waals interactions, the energy of rupture of hydrogen bonds, vapor pressure, and other physicochemical properties was examined. (tr-auth)

21691 MASS SPECTROMETRIC STUDY OF THE EVAPORATION OF THE CERAMICS UO_2 AND UC. Pattoret, A.; Drowart, J. Smoes, S. (CEA, Saclay, France). Bull. Soc. Fr. Ceram., No. 77, 75-90(1967). (In French).

A comparative method allows the measurement of small deviations of pressure for systems of similar activity with high precision. When the equilibria for comparison are studied with effusion cells, the pressure reference is a non-evolving material at the same temperature. In the U–O system the difference between the vapor pressures of UO_2 (gas) in equilibrium with the stoichiometric dioxide, the congruent-evaporation composition, and the metal-saturated dioxide was studied above 2000°K. In the U–C system, U pressures in equilibrium with the carbide of composition $UC_{1.04}$ studied were found to fit $\log P_U(\mathrm{atm}) = 7.51 - (3.35 \times 10^4)/T$. A rapid increase in the evaporation rate from a monocarbide surface towards a congruent evaporation was confirmed; the data at 2500°K confirmed published results. A coefficient of evaporation near 1 for U and less than 0.1 for gaseous UC_2 was found. Thermodynamic evaluation of the results confirms the high value of the heat of sublimation of U, 128.5 ± 2.0 Kcal/atg. (BBB)

21692 PHASE STUDIES OF THE PRODUCTS FROM THE NITRIDATION OF TITANIUM, ZIRCONIUM, HAFNIUM, AND CHROMIUM. Lyutaya, M. D.; Kulik, O. P. Zavod. Lab., 35: No. 1, 25-7(1969). (In Russian).

Phase studies were made of the products from the nitridation of Ti, Zr, Hf, and Cr based on the difference in stability in hydrochloric and sulfuric acids of the metal nitrides, pure metals, or solid solutions of nitrogen in the metals. (tr-auth)

21693 HEPTAVALENT STATE OF TRANSURANIUM ELEMENTS. II. PREPARATION AND STUDY OF CERTAIN PROPERTIES OF PLUTONIUM(VII). Komkov, Yu. A.; Krot, N. N.; Gel'man, A. D. Radiokhimiya, 10: 625-9(1968). (In Russian).

Methods of producing Pu(VII), its identification, and its most important properties are described. Plutonium was produced in the heptavalent state by oxidation of Pu(VI) by ozone in alkaline media. The relation of Pu(VII) to the order of reducing agents (H_2O_2, $K_4Fe(CN)_6$, N_2H_4, and others) showed that, on careful titration of Pu(VII) by reducing agents, it is possible to fix its one-electron transition in the hexavalent state. Other conditions for oxidation of Pu(VI) to the heptavalent state were studied. A solid compound of plutonium with Ba^{2+} that corresponds to the hypothetical formula $Ba_3(PuO_5)_2 \cdot nH_2O$ was found. (tr-auth)

21694 HEPTAVALENT STATE OF TRANSURANIUM ELEMENTS. III. PROPERTIES OF CERTAIN SOLID COMPOUNDS OF NEPTUNIUM(VII). Krot, N. N.; Mefod'eva, M. P.; Zakharova, F. A.; Smirnova, T. V.; Gel'man, A. D. Radiokhimiya, 10: 630-4(1968). (In Russian).

The solubility and other properties of a previously synthesized compound of neptunium(VII) with $[Co(NH_3)_6]^{3+}$ were studied. Its solubility product in 1M NaOH at 20°C was found to be $(5.1 \pm 1.1) \times 10^{-8}$. Results of the investigations conducted confirmed that Np(VII) exists in alkaline solutions in the form of the anion NpO_5^{3-}. (tr-auth)

21695 HEPTAVALENT STATE OF TRANSURANIUM ELEMENTS. IV. FORMS OF EXISTENCE OF NEPTUNIUM(VII) IN AQUEOUS SOLUTIONS. Krot, N. N.; Mefod'eva, M. P.; Gel'man, A. D. Radiokhimiya, 10: 634-46(1968). (In Russian).

Heptavalent neptunium in alkaline media exists in the form of NpO_5^{3-} ions, which are the anionic form of the amphoteric hydroxide $NpO_2(OH)_3$. The latter is formed as a black precipitate on careful neutralization of solutions of Np(VII) up to pH < 10. $NpO_2(OH)_3$ is dissolved in mineral acids with the formation of NpO_2^{3+} ions possessing an intense brown color. In the absorption spectrum of NpO_2^{3+} there is a wide band of absorption with a maximum at 410 mm. The cation NpO_2^{3+} is the final member of the homologous order NpO_2^{n+}, where n varies from 0 to 3 on increase of the neptunium valence from 4 to 7. Also expressed is a premise concerning the existence of a homologous order for plutonium (tr-auth)

21696 FAST REACTIONS AND PRIMARY PROCESSES IN CHEMICAL KINETICS. Proceedings of the Fifth Nobel Symposium held August 28–September 2, 1967 at Soedergarn, Lidingoe, in the County of Stockholm. Claesson, Stig (ed.). Nobel Symposium 5. New York, John Wiley and Sons, Inc., 1968. 487p. $27.50. (CONF-670844).

Twenty-four papers presented at the symposium are included. Topics covered included: rate theory of elementary processes, fast reactions, excited state and primary process studies, measurements of reactions in the 10^{-1}- to 10^{-6}-second range, quantum theory of dissipative systems and scattering processes, reaction of deuterium with hydrogen, photolysis, energy transfer, chemistry of the electron, reactions of electrons with molecules, acid-base processes, proton transfer, analysis of photosynthesis by pulse techniques, fluorescence measurements, reaction control and information transfer in enzymes and nucleic acids, dissipative structures in chemical systems, kinetics of complex systems, isomerization at the C = N double bond, physical chemistry of nerve action, and electron-transfer in excited molecules. Separate abstracts were prepared for two papers. (M.C.G.)

For abstracts of individual papers see: 21702 and 22876.

21697 NEW SULFIDE OF PENTAVALENT URANIUM AND POTASSIUM. Padiou, Jean; Guillevic, Joseph (CNRS, Rennes, France). Compt. Rend., Ser. C, 268: 822-4(Mar. 3, 1969). (In French).

A new sulfide of uranium and potassium, KUS_3, was isolated in the crystalline form. Magnetic measurements show that the uranium in it is pentavalent. The crystal lattice of KUS_3 is orthorhombic with a = 3.99, b = 5.36, and c = 20.56A; the possible spatial group is Immm, Imm2, or I222. (tr-auth)

21698 REACTIVITY OF ALPHA AND BETA POSITIONS IN THIOPHENES. A SEMIQUANTITATIVE STUDY WITH SPECIAL REGARD TO ELECTROPHILIC AROMATIC SUBSTITUTION. Oestman, Boerje (Research Inst. of National Defence, Stockholm). FOA (Forsvarets Forsk.) Rep., 3: 1-20(Jan. 1969).

The history of thiophene chemistry since 1950 is summarized in some detail. The discussion is presented under the following headings: isotope effects in electrophilic substitution, molecular orbital treatment of the reactivity of thiophenic positions, electrophilic substitution of monosubstituted thiophenes, side-chain reactions in the thiophene series, and summaries. (57 references). (B.L.M.)

21699 ANHARMONICITY AND HYDROGEN BONDING: ISOTOPIC SUBSTITUTION. Asselin, M.; Belanger, G.; Sandorfy, C. (Univ., Montreal). J. Mol. Spectrosc., 30: 96-101(Apr. 1969).

The fundamentals and first overtones of the free and self-associated OH stretching bands of three alcohols and phenol were measured, the associated bands at liquid air temperature in rigid glasses. The dependence of the frequencies and anharmonicity constants on deuterium substitution was examined.

The result is a new proof that hydrogen bonding has a profound influence on the anharmonicity of OH stretching vibrations. (auth)

21700 PHYSICO-CHEMICAL PROPERTIES OF SOLID BINARY ELECTROLYTES $(ZrO_2)(CeO_2)$. Asquiedge, M.; Busson, N.; Guillou, M.; Jacquin, M.; Lecante, A.; Millet, J.; Palous, S.; Pithon, M. (Electricite de France, Clamart). Rev. Int. Hautes Temp. Refract., 6: 35-44(Jan.-Mar. 1969). (In French).

The electric, electrochemical, and crystallographic properties of the binary system zirconia–cerium oxide were studied. At high temperature the couple Ce^{3+}/Ce^{4+} introduces an important electronic semi-conductivity. The electrochemical properties of CeO_2-ZrO_2 system depend on the chemical potential of oxygen in the gaseous atmosphere around the sample. Results of studies on the electric conductivity and transport numbers as a function of chemical potential of oxygen, and on thermogravimetric researches are presented. The results are explained with the help of Kröger–Wagner theory of semi-conductivity. (J.G.B.)

21701 VACUUM-ULTRAVIOLET STUDY OF LIQUID H_2O AND D_2O. Verrall, R. E.; Senior, W. A. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys., 50: 2746-50(Mar. 15, 1969).

Vacuum-ultraviolet spectra of liquid D_2O and H_2O were obtained at several temperatures in the wavelength range 1300 to 1750 Å. Because of the very large extinction coefficient of water in this region, the absorption spectra were obtained from very thin liquid films. The results show that the vapor–liquid shift is to the blue by some 7000 cm^{-1}. The spectra are discussed in terms of the effect of temperature on hydrogen-bonding properties of the liquids in the ground state and the nature of the electronic transitions from which they arise. (auth)

21702 REACTION OF MONOENERGETIC DEUTERIUM ATOMS WITH HYDROGEN MOLECULES. Kuppermann, Aron (California Inst. of Tech., Pasadena). pp 131-40 of Fast Reactions and Primary Processes in Chemical Kinetics. Claesson, Stig (ed.). New York, John Wiley and Sons, Inc., 1968. (CALT-532-17).

From 5th Nobel Symposium, Lidingoe, Sweden. See CONF-670844.

Reaction cross sections and rate constants for crossed beam deuterium atom–hydrogen molecule reactions are discussed. Deuterium atoms are produced by photolysis of DI. A theoretical analysis of monochromatic atom reactions is presented. (M.C.G.)

21703 ISOTOPIC EXCHANGES OF TUNGSTEN BETWEEN DIFFERENT TUNGSTIC IONS. Wolff, Charles-Michel; Schwing, Jean-Paul (Institut de Chimie, Strasbourg). Compt. Rend., Ser. C, 268: 674-6(Feb. 24, 1969). (In French).

The exchange of ^{185}W between normal tungstate and paratungstate A on the one hand and between normal tungstate and metatungstate on the other hand was studied. By using an electrophoretic method of separation of these different ions a rapid exchange at 25°C was found for the first system and a slower exchange for the second system for which the rate constant for the exchange was determined at 88.5°C. (tr-auth)

21704 PREPARATION OF A NEW OXYHALOGENIDE OF PENTAVALENT URANIUM, UO_2Cl. MAGNETIC SUSCEPTIBILITY OF UO_2Cl AND UO_2Br. Levet, Jean-Claude (Faculte des Sciences, Rennes, France). Compt. Rend., Ser. C, 268: 703-5 (Feb. 24, 1969). (In French).

UO_2Cl was prepared by the reaction of anhydrous UO_2Cl_2 or of UCl_4 with the oxides UO_2 or U_3O_8, respectively. The study of the magnetic susceptibility of UO_2Cl and that of UO_2Br, prepared previously, proved that the uranium has a valence of five. (tr-auth)

21705 COMPLEXES OF PLUTONIUM(III) WITH ACETATE. Magon, L.; Cassol, A.; Portanova, R. (CNR, Fadua). Inorg. Chim. Acta, 2: 285-8(Sept. 30, 1968).

The Pu(III) acetate system $Pu(Ac)_n^{3-n}$, was studied by means of potentiometric $[H^+]$ measurements and a spectrophotometric check on the real oxidation state of the Pu. A perchlorate medium of ionic strength $I = 2\underline{M}$ was used at 20°C. The limited interval of acetate concentration within which the system was examined permits following the formation of successive complexes up to a maximum value for $\bar{n}$ of about 1.2. Within these limits, the data relating to the 4 different initial concentrations of Pu(III) show that $\bar{n}$ is, to a good approximation, a function only of the concentration of the free ligand, and is independent of that of the metal cation. Appreciable formation of polynuclear complexes or of complexes with nonprotolyzed acid is thus excluded. The value of the formation constant β_1 was determined. An approximate value of the constant β_2 was determined since the data are insufficient for an accurate extrapolation. The values obtained for the constants are: $\beta_1 = 105 \pm 4\ \underline{M}^{-1}$; $\beta_1 = 2200 \pm 250\ \underline{M}^{-1}$. The deviation from the experimental points for the higher values of log [A] may be due to the equilibrium formation of a third complex, and/or to the oxidation of a small amount of Pu(III). Hydrolysis of the metal cation may be neglected in the pH range examined. The values of the new constants together with those reported on the literature for the complexes of Pu(III), Sm(III), and Am(III) with acetate ion are compared. (BBB)

21706 HYDROGEN–DEUTERIUM EXCHANGE STUDIES ON CHYMOTRYPSINOGEN A, α-CHYMOTRYPSIN, AND DIISOPROPYLPHOSPHORYL-α-CHYMOTRYPSIN. Willumsen, Lars (Carlsberg Lab., Copenhagen). Compt. Rend. Trav. Lab. Carlsberg, 36: 327-45(1968).

The H–D exchange reaction between heavy water and peptide hydrogen atoms in chymotrypsinogen A, α-chymotrypsin, and diisopropylphosphoryl-α-chymotrypsin was studied at 21°C by measuring the decrease of the amide II band absorption at 1545 cm^{-1} relative to the amide I band absorption. Over a broad pH and pD range chymotrypsinogen showed at all times of incubation about 5% more exchanged peptide hydrogens than α-chymotrypsin. Diisopropylphosphoryl-α-chymotrypsin had nearly the same number of unexchanged peptide hydrogens after 2½ hr as chymotrypsinogen. The H–D exchange fitted a model, in which rapid equilibrium between a closed and an open molecular conformation is assumed and in which only the open form is expected to exchange. (BBB)

21707 MOLECULAR ASPECTS OF HYDROGEN–DEUTERIUM EXCHANGE IN MACROMOLECULES. Klotz, Irving M. (Northwestern Univ., Evanston, Ill.). J. Colloid Interface Sci., 27: 804-17(Aug. 1968).

Hydrogen–deuterium exchange in peptide CONH groups is traditionally examined from a restrictive viewpoint, merely that of a chemical probe for the measurement of α-helix content of polypeptides and proteins. Studies with model amides show, however, that H–D exchange is also very sensitive to H^+, OH^-, general acids and general bases, and other features of the environment of the CONH group. Comparison of synthetic macromolecules, containing amide groups, with small molecules reveals many similarities in behavior of the H–D exchange reaction, but also striking differences in rate constant under certain conditions. The effect of the macromolecular environment can be understood in terms of the molecular details of the mechanism of exchange. It is thus profitable to consider H–D exchange as a particularly simple example of a chemical reaction whose kinetic character is altered in a polymeric matrix and to use these studies as a basis for understanding the modified behavior of this and other reactions in a protein environment. (BBB)

21708 COMPLEXES OF PLUTONYL ION WITH ACETATE. Magon, L.; Portanova, R.; Cassol, A. (CNR, Padua). Inorg. Chim. Acta, 2: 237-40(Sept. 30, 1968).

Complex formation between plutonyl and acetate ion was investigated by potentiometric $[H^+]$ measurements. The values of the complex constants of 3 mononuclear complexes were determined in a perchlorate medium of ionic strength $I = 1\underline{M}$ at 20°C. Good agreement of the formation curves obtained with 2 different buffers shows that under these conditions the plutonyl ion does not undergo hydrolysis. Overlap (within the limits of experimental error) of the formation curves obtained from measurements at different initial concentrations of PuO_2^{2+} shows that, at least in the range of the concentrations examined, there is formation of mononuclear complexes only. Comparison of the data with values of the stability constants of the UO_2^{2+} acetate complexes shows that plutonyl has a lower tendency to coordinate acetate ions in aqueous solution than has uranyl. The formation constants β_n for the acetate system of plutonyl are: $\beta_1(M^{-1})$, 112 ± 4; $\beta_2(M^{-2})$, $(3.5 \pm 0.5) \times 10^3$; and $\beta_3(M^{-3})$, $(9.2 \pm 2.0) \times 10^4$. Since plutonyl behaves as a larger ion than uranyl towards oxygen or water molecules about the equator, it is reasonable to invoke this idea to explain different tendencies towards the formation of acetate complexes. The possibility remains that the different electronic structures of uranyl and plutonyl may have some importance. (BBB)

21709 FLUORESCENCE QUENCHING AND ISOTOPE EFFECT OF TRYPTOPHAN. Eisinger, J.; Navon, G. (Bell Telephone Lab., Inc., Murray Hill, N. J.). J. Chem. Phys., 50: 2069-77(Mar. 1, 1969).

The fluorescence spectra and quantum yields of tryptophan (TRP) and several tryptophan derivatives in water and a polar glass have been measured over wide temperature ranges. For TRP, the wavelength of maximum emission shifts from 310 nm at 80°K to 355 nm at room temperature with almost all of the red shift occurring between 170 and 230°K, which is the temperature range where the glass softens. The successively more red-shifted spectra have no isoemissive wavelength, which supports the view that reorientation of several solvent molecules in the solvent shell of the excited TRP molecule and not a 1 : 1 exciplex is responsible for the red shift. The quantum yield remains constant until a temperature is reached at which solvent reorientation is virtually complete. Above that temperature, the quenching of the 355-nm emission can be fitted with a nonradiative de-excitation having an activation energy of 7 kcal/mole. A model for these spectral changes and quenching mechanism will be offered. In deuterated solvents, a large isotope effect of fluorescence yield of TRP has been reported. This effect is clearly not caused by proton transfer in the excited state since it was found to be virtually the same for TRP and 1-Me-TRP. At temperatures below those at which solvent reorientation occurs, the isotope effect vanishes, and above them it approaches an asymptotic value, the quenching activation energy being independent of the isotopic constitution of the solvent. The fluorescence of most proteins and hormones originates in their tryptophan residues. The quantum yields, isotope effects, and emission spectra of such polypeptides were compared with the corresponding parameters for solvated TRP. (auth)

21710 INVESTIGATION OF ION-EXCHANGE KINETICS BY A POTENTIOMETRIC METHOD. Ciric, Milan M. Bull. Boris Kidric Inst. Nucl. Sci., Chem., 19: No. 3, 13-20(June 1968).

A potentiometric method of investigating ion-exchange kinetics was developed. The method can be applied to the ion-exchange reactions which change the pH of the solution phase. The rate of exchange and the rate-controlling step were determined for various commercial cation and anion exchangers (Amberlite IR-120, Dowex 50, 1, and 2, Wofatit SBW, L-150, F, CP, and CN). (auth)

21711 INELASTIC SCATTERING OF COLD NEUTRONS IN $C_3H_5(OD)_3$ AT VARIOUS TEMPERATURES. Rapeanu, S. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 913-16 (1968).

Results obtained for partially deuterated glycine at various temperatures by using cold-neutron spectrometry are considered. The frequency spectra were derived. The peak assigned to proton-hindered rotations of the OH group in $C_3H_5(OH)_3$ could not be found in the spectra of $C_3H_5(OD)_3$ or it was displaced to lower frequencies. (M.C.G.)

21712 PHOTOMETRIC DETERMINATION OF COMPOSITION AND CONDITIONAL STABILITY CONSTANTS OF COMPLEXES A_mB_n. Budesinsky, B. (Inst. for Nuclear Research, Rez, Czech.). J. Inorg. Nucl. Chem., 31: 1345-52(May 1969).

The method of proportional absorbances was generalized and applied both to the determination of absolute values of complex composition A_mB_n and of its conditional stability constant. The method of continuous variation or of molar ratio is suitable for determination of absolute values of the composition of the very stable complex A_mB_n. Among the complexes considered are Zr Arsenazo (III), La Dicarboxyarsenazo (III), and U(VI) Chlorophosphonazo (III). (UK)

21713 HYDROGEN–DEUTERIUM EXCHANGE OF THE THIAPYRONES, N-METHYLPYRIDONES, AND N-METHYLPYRIMIDONES IN BASIC MEDIA. Beak, Peter; Monroe, Elizabeth McLeister (Univ. of Illinois, Urbana). J. Org. Chem., 34: 589-96(Mar. 1969).

Base-catalyzed hydrogen–deuterium exchange occurs at the positions adjacent to the heteroatom for 4-thiapyrone (A), N-methyl-2-pyridone (B), 4-methoxy-N-methylpyridinium fluoroborate (C), and 1,3-dimethyl-4-pyrimidonium fluoroborate. The rates of exchange, relative to that of N-methyl-4-pyridone in deuterium oxide at 100°, are for A, $10^{4.8}$ (deuterium oxide at 100°); B, $10^{-0.8}$ (deuterium oxide at 100°); and C, $10^{5.3}$ (deuteriomethanol at 40°). Attempts to observe isotopic exchange at the corresponding positions in 2-thiapyrone, 2-pyrone, and 4-pyrone led to substrate decomposition. Hydrogen–deuterium exchange at the 2 position of 3-methyl-4-pyrimidone and 1-methyl-4-pyrimidone in deuterium oxide at 100° is zero order in base as previously reported. These results are interpreted qualitatively in terms of ylide intermediates. (auth)

21714 PREPARATION AND LUMINESCENCE PROPERTIES OF LANTHANUM OXYSULFIDE ACTIVATED WITH EUROPIUM. Loriers, Jean; Baron, Monique; Blanzat, Bernard; Collin, Gaston (CNRS, Bellevue, France). Compt. Rend., Ser. A, B, 268: 642-5(Feb. 24, 1969). (In French).

The oxysulfide of activated lanthanum with europium was prepared by the processing, at 1350°C in argon, of mixtures of La_2O_3 and Eu_2O_3 (2 moles) and of the sulfide, La_2S_3 (1 mole). The compound possesses a hexagonal structure common to all oxysulfides of rare earths with a = 4051 Å, c = 6943 Å. Under ultraviolet excitation it shows a red fluorescence characteristic of the Eu^{3+} ion with an intensity maximum for concentrations of the 5 moles % of europium. The maximum response for the fluorescence is obtained for wave lengths of excitation about 3600 to 3700 Å. The light emission originates from electron transitions between the excited states of $^5D_0$ and $^5D_1$ of Eu^{3+} and the fundamental multiplet ^7F_n. These excited levels are shown in the same way as the higher energy levels ($^5D_2$, $^5D_3$, etc.) by the absorption spectra. These results show the role of direct excitation of the ion Eu^{3+} in the mechanism of fluorescence. (tr-auth)

21715 COORDINATED COMPOUNDS OF URANYL WITH POTASSIUM AND RUBIDIUM. Davidovich, R. L.; Kalacheva, T. A. Izv. Sib. Otd. Akad. Nauk SSSR, No. 12, Ser. Khim. Nauk, No. 5, 44-7(Sept. 1968). (In Russian).

The systems $KF-UO_2F_2-H_2O$ and $RbF-UO_2F_2-H_2O$ have been investigated by the molar rate method from 1 : 1 to 20 : 1. Three individual coordinated fluorides $Rb_3UO_2F_5$, $Rb_2(UO_2)_3F_8 \cdot 4H_2O$, and $Rb_2UO_2F_4 \cdot H_2O$ were formed in the system $RbF-UO_2F_2-H_2O$. Thermal decomposition of the compounds was investigated. (auth)

21716 FAR-INFRARED SPECTRA OF CRYSTALLINE ETHYLENE C_2H_4 AND C_2D_4. Brith, Malka; Ron, Arza (Israel Inst. of Tech., Haifa). J. Chem. Phys., 50: 3053-6(Apr. 1, 1969).

The far-infrared spectra of polycrystalline ethylene were recorded at various temperatures between 65° and 20°K and at 8°K. Two bands were observed both for ethylene and ethylene-d_4. The frequency ratio of corresponding bands in ethylene and deuteroethylene prove that these absorption bands are due to translational lattice modes. Absolute intensities of the observed bands in ethylene were measured. The frequencies of the translational lattice modes were calculated for two different models of intermolecular forces, i.e., center-to-center Lennard–Jones potential and atom–atom repulsion potential. (auth)

21717 SPECTROSCOPIC PROPERTIES OF INORGANIC AND ORGANOMETALLIC COMPOUNDS. VOLUME 1. Review of the Literature Published during 1967. Greenwood, N. N. London, The Chemical Society, 1968. 405p. 100s.

Data are included on the following topics relating to nuclear materials: Characteristic frequencies and electronic spectra of inorganic complexes of Zr, Hf, V, Nb, Ta, Mo, W, Tc, lanthanides and actinides; Moessbauer spectra of rare earths. (UK)

21718 THE SOLUTION ABSORPTION SPECTRUM OF Es^{3+}. Fujita, D. K.; Cunningham, B. B.; Parsons, T. C.; Peterson, J. R. (Univ. of California, Berkeley). Inorg. Nucl. Chem. Lett., 5: 245-50(Apr. 1969).

The availability of a larger quantity of Es allowed confirmatory studies of earlier observations possible (loc. cit., 3: 519(1967)), and results are given of experimental work that produced much improved spectra in the region 3,700 to 10,600 Å. Details are given of the Es material used and of the absorption cell employed. All spectra were obtained in 3 to 6M HCl solutions, with Es^{3+} concentrations of ~0.1 to ~5M and solution volumes ranging from ~100 to ~3 nanoliters. Two sets of spectra were examined: (a) in the region 3,400 to 7,500 Å using ~3.5 μg ^{253}Es within 33 hr of separation of its decay product ^{249}Bk by cation exchange; (b) in the region 3,300 to 10,600 Å using ~3 μg ^{253}Es within 56 hr following separation. Results are shown in tabular and graphical form. The observed Es^{3+} solution spectrum was compared with the theoretically derived spectra for the $5f^{10}$ (Es^{3+}) configuration calculated by Fields et al.; agreement was considered unsatisfactory. The energy of the first excited electronic state of Es^{3+} in the $5f^{10}$ configuration is discussed. (UK)

21719 FACTORS AFFECTING THE FORMATION AND STABILITY OF THE EQUILIBRATING PROTONATED CYCLOPROPANE. Friedman, Lester; Jurewicz, Anthony (Case Western Reserve Univ., Cleveland). J. Amer. Chem. Soc., 91: 1800-3(Mar. 26, 1969).

Deamination of n-propyl-3,3,3-d_3-amine and n-propyl-2,2,-d_2-amine gave hydrocarbon mixtures containing cyclopropane and propene. The deuterium content of the cyclopropane varied with the reaction medium. This is attributed to solvent dependency on the extent of equilibration of the intermediate protonated cyclopropane. Routes for propene formation are also suggested. (auth)

21720 TRANSPORT NUMBER MEASUREMENTS WITH RADIOISOTOPES IN AQUEOUS ELECTROLYTE SOLUTIONS OF VERY LOW CONCENTRATIONS. Marx, G.; Riedel, W.; Vehlow, J. (Freie Univ., Berlin). Ber. Bunsenges. Phys. Chem., 73: 74-9(Mar. 1969). (In German).

The transport number of the Co^{2+} ion component in aqueous $CoCl_2$ solution was measured at 25°C and at concentrations between 10^{-1} and 10^{-4} N with the method of the moving boundary, using the radioisotope technique. The radioisotope used was the γ-emitting Co-60, the indicator ion was Li^+. The investigations show that $CoCl_2$/LiCl-interfaces are unstable below 10^{-3}N; therefore the measurements at 10^{-4}N were conducted with the method using identical solutions. The transport number of the Co^{2+} ion at infinite dilution is 0.4121, which leads to an equivalent ionic conductivity of Co^{2+} at infinite dilution of (53.5 ± 0.1) [$cm^2\ \Omega^{-1}\ val^{-1}$]. A comparative error analysis for the radioisotope method and the usual optical procedure is given. (auth)

21721 NUCLEAR MAGNETIC RESONANCE OF THE DEUTERON IN LANTHANUM DIDEUTERIDE ABOVE AMBIENT TEMPERATURE. Barrere, Helene (CNRS, Paris). Compt. Rend., Ser. C 268: 895-7(Mar. 10, 1969). (In French).

The study of the amplitude of the deuteron resonance rays in the phase LaD_2 of samples of $LaD_{1.40}$ and $LaD_{1.85}$ shows a contraction of the rays that start near 80°C for the two samples and then shows a different course for the two compositions studied. The results at temperatures above 80°C are explained by a mechanism of the diffusion of the deuterium atoms which put in play a temporary occupation of the octahedral sites by the deuterium, which depends on the ratio metal/deuterated metal. The hypothesis of Frenkel for defects in the lattice of deuterium atoms is not compatible with the experiments reported here although the hypothesis of Schottky for defects of the lattice of lanthanum is in accordance with the observations. (tr-auth)

21722 TWO ASPECTS OF THE COMPLEXITY OF THE VIBRATIONS ν(CH) AND ν(CD) IN PENTASUBSTITUTED COMPOUNDS. Marcou, Agnes; Freymann, Rene (Faculte des Sciences, Paris). Compt. Rend., Ser. C, 268: 919-21(Mar. 10, 1969). (In French).

Intramolecular and intermolecular perturbations in the characteristic infrared frequencies are reported for ν(CH) and ν(CD) for HC_6F_5, DC_6F_5, HC_6Cl_5, and ortho and para $HC_6Cl_4NO_2$. (tr-auth)

21723 ADVANCES IN INORGANIC CHEMISTRY AND RADIOCHEMISTRY. VOLUME 11. Emeleus, H. J.; Sharpe, A. G. (eds.). New York, Academic Press Inc., 1968. 475p. $18.50.

Topics included are: transition metal complexes with group IV-B elements, silicon hydrides and their derivatives, some general aspects of mercury chemistry, and alkyl derivatives of the group II metals. Separate abstracts have been prepared for articles on metal carbides and technetium. (J.G.B.)

For abstracts of individual papers see: 21646 and 21647.

21724 POLAROGRAPHIC INVESTIGATION OF URANYL COMPLEXES IN NONAQUEOUS SOLVENTS. URANYL ACETYLACETONATE, URANYL BISDIBENZOYLMETHANE COMPLEX, AND URANYL 8-QUINOLONOLATES IN PROPANEDIOL-1,2-CARBONATE, N,N-DIMETHYLFORMAMIDE, N,N-DIMETHYLACETAMIDE, AND DIMETHYL SULFOXIDE. Fleischer, H.; Bildstein, H.; Gutmann, V. (Technische Hochschule, Vienna). Mikrochim. Acta, No. 1, 160-6(1969). (In German).

The polarographic behavior of uranyl complexes with acetylacetone, dibenzoylmethane, and 8-hydroxyquinoline was investigated in propanediol-1,2-carbonate, N,N-dimethylformamide, N,N-dimethylacetamide, and in dimethyl sulfoxide. The position of the half-wave potentials (vs. aqueous saturated calomel electrode at 25°), the nature of the limiting currents, their dependency on the temperature between 15 and 35°C, and the influence of water are described. In the case of reversible processes, the stability of the complexes in the solution are estimated. Because of the good solubilities of the chelate complexes in the solvents used and the validity of the Ilkovič-equation for the waves ($c = 5 \times 10^{-5}$ to 3×10^{-3} m), it is possible to analyze polarographically the precipitated or extracted uranyl complexes. (auth)

21725 THE PHOTOCHEMISTRY OF SILICON COMPOUNDS. III. THE VACUUM-ULTRAVIOLET PHOTOLYSIS OF METHYLSILANE. Obi, K.; Clement, A.; Gunning, H. E.; Strausz, O. P. (Univ. of Alberta, Edmonton). J. Amer. Chem. Soc., 91: 1622-30(Mar. 26, 1969).

The gas-phase photolysis of methylsilane at the xenon and krypton resonance lines proceeds via the following primary steps with values of ϕ(Xe) and ϕ(Kr) given, respectively, in parentheses: $CH_3SiH_3 + h\nu \rightarrow$ (step 1) $CH_3SiH^* + H_2$ (0.32, 0.16); (step 2) $CH_3SiH + 2H$ (0.05, 0.09); (step 3) $CH_2SiH_2^* + H_2$ (0.23, <0.37 (0.14)); (step 4) $CHSiH_3 + H_2$ (0.07, 0.11); (step 5) $CH_4^* + SiH_2$ (0.09, 0.08); (step 6) $CH_3 + H + SiH_2$ (0.26, 0.25); (step 7) $CH_3 + H_2 + H + Si$ (0.00, 0.17); (step 8) $CH_3 + SiH_3^*$ (~0.02, 0.00). The total values of ϕ(Xe) and ϕ(Kr) are 1.04 and <1.23 (1.00), respectively. The asterisks signify hot products which may undergo further decomposition, thereby contributing to an additional apparent primary step. Increasing photonic energy increases this fragmentation. Final products in decreasing order of importance are H_2, $CH_3SiH_2SiH_2CH_3$, $CH_3SiH_2SiH_3$, CH_4, C_2H_6, $CH_3SiH_2CH_3$, SiH_4, and a solid polymeric material. The mechanism was deduced from the effect of exposure time, pressure, use of scavengers such as NO and C_2D_4, and deuterium labeling on product yields. The nature of products, in accord with the observed kinetics, unambiguously points to the intervention of two kinds of silene diradicals in the mechanism. Both are present in a singlet electronic state and readily insert into the Si–H bond of the substrate to give hot, methylated disilanes. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 21725, 21770, 21772, 21775, and 23946.

21726 (AI-AEC-12744, pp 159-61) RADIATION CHEMISTRY. (Atomics International, Canoga Park, Calif.).

The pulse radiolysis of naphthalene was studied to determine the relative yields of excited molecules in triplet and singlet states, and to assess the role of intersystem crossing in triplet state formation. The excited singlet state was observed both by emission and by absorption spectroscopy. When, 1,2-benzanthracene was added to the naphthalene, singlet–singlet transfer occurred. An ESR study of anions of purines, pyrimidines, and aromatic hydrocarbons has begun. The anions are prepared either electrolytically or by alkali metal reduction. A computer program necessary to analyze the ESR spectra of radical ions and to determine the location of unpaired spin was completed. (D.H.M.)

21727 (AI-AEC-12744, pp 179-82) RADIATION CHEMISTRY OF CHROMOSOMES. (Atomics International, Canoga Park, Calif.).

Studies are being made to correlate molecular alterations with biological damage to mammalian chromosomes caused by radiation. Radical sites in irradiated chromosomes will be determined by tritium labeling. Deoxyribose-5-phosphate was found to be reactive toward hydrogen atoms. A computer method was used to analyze ESR spectra obtained by bombardment of DNA with hydrogen atoms to determine the radicals formed. Reactions of electrons with nucleic acid bases to form anions after irradiation of DNA were studied. (M.C.G.)

21728 (JUL-560-PC) USE OF FUEL ELEMENTS IN PREPARATIVE RADIATION CHEMISTRY AND THE ONIUM SALT DOSIMETER. Drawe, H.; Faul, W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie). Nov. 1968. 10p. (In German). Dep.

Dose-rate measurements and preparative radiation chemical synthesis were carried out using burnt-out fuel elements from the reactor FRJ-2 (DIDO). For this purpose, the applicability of a new, readily available dose-rate meter was evaluated. The usefulness of burnt-out fuel elements as γ sources for the synthesis of new compounds on a preparative scale was investigated. To this end a simple irradiation apparatus was developed. (auth)

21729 (NP-tr-1746) CHEMICAL FORMS OF RADIOCARBON PRODUCED BY THE REACTION $^{14}N(n,p)^{14}C$ IN BERYLLIUM, MAGNESIUM, CALCIUM, ALUMINUM, AND ZIRCONIUM NITRIDES. Kuhry, J.-G.; Adloff, J.-P. Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from Bull. Soc. Chim. Fr., 9: 3414-18(1967). 15p. Dep. Handwritten MS. copy.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 4183. (TSS)

21730 (NP-tr-1751) CHEMICAL EFFECTS OF NUCLEAR PROCESSES IN MIXED CRYSTALS. I. CHEMICAL EFFECTS OF THE REACTION $^{185}Re(n,\gamma)^{186}Re$ IN $K_2ReBr_6-K_2SnCl_6$ MIXED CRYSTALS. Mueller, H. Translated by B. K. Bowes (Atomic Energy Research Establishment, Harwell, Eng.), from J. Inorg. Nucl. Chem., 27: 1745-59(1965). 31p. Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 19: 40585. (TSS)

21731 PULSE RADIOLYTIC INVESTIGATION OF THE REDUCTION OF Ag^+ IONS IN AMMONIA SOLUTIONS. Pukies, J.; Roebke, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Phys. Chem., 72: 1101-5(Dec. 1968). (In German).

Several elementary reactions of the reduction of Ag^+ in aqueous solution are influenced by ammonia. This is explained by complex formation of the charged intermediate products. $Ag_{2(am)}^{+}$ is formed in the reactions $e_{aq}^- + Ag(NH_3)_2^+ \rightarrow Ag$ and $Ag + Ag(NH_3)_2^+ \rightarrow Ag_{2(am)}^+$ as in the absence of ammonia. $Ag_{2(am)}^+$ reacts with itself at low and with $Ag(NH_3)_2^+$ at high Ag^+ concentration. Long lived complexes of the reactants are formed in both processes, the first order decay of which was observed. $Ag(NH_3)_2^+$ is oxidized by the OH radical to yield $Ag_{(am)}^{2+}$. The divalent silver lives longer when it is complexed. Nuclei of colloidal silver are formed as end products of the reduction in the presence of ammonia as in aqueous solution. (auth)

21732 RELATIVE REACTIVITY OF BENZENE AND MESITYLENE TOWARDS TRITIUM ATOMS. Adsetts, J. R.; Gold, V. (King's Coll., London). J. Chem. Soc., D, No. 7, 353-4 (Apr. 9, 1969).

Reference is made to studies of reaction between aromatic hydrocarbons and T-atoms by investigating radioinduced T exchange in aqueous solution, and it seemed of interest to ascertain whether the relative reactivities of hydrocarbons could be determined by this technique. Such studies also throw light on the basic question as to whether aromatic hydrocarbons react with T-atoms to form products other than those arising from T addition to the aromatic ring. A study is described of the inhibition by added benzene, in low concentration, of the β-radioinduced T uptake by mesitylene. It was concluded that the most important reaction of T-atoms with mesitylene, or benzene, is that leading to T-labeling of the hydrocarbon, and hydrogen abstraction by T-atoms from the hydrocarbons appears to be less important than addition leading to substitution. The measured large reactivity ratio represented very nearly the ratio for attachment of T-atoms. (UK)

21733 THERMAL ANNEALING AND THERMAL EXCHANGE IN A FEW NEUTRON IRRADIATED AND $^{60}Co^{2+}$ DOPED ETHYLENEDIAMINETETRAACETATE CHELATES RESPECTIVELY. Khorana, S.; Nath, Amar (Bhabha Atomic Research Center, Trombay, India). J. Inorg. Nucl. Chem., 31: 1283-8(May 1969).

Thermal annealing of recoil damage in neutron irradiated EDTA complexes of Co(II), Co(III) and Ni(II) was studied. In each case three species were radiosynthesized, Viz., Co^{2+}, $[Co(II)(C_{10}H_{12}N_2O_8)]^{2-}$ and $[Co(III)(C_{10}H_{12}N_2O_8)]^-$. A method of separation was developed to find the percentage radiosyntheses of each of the three species and the change in their distribution on thermal treatment. Thermal exchange was also observed in the radiocobalt-doped chelates. The patterns for thermal exchange and thermal annealing were found to be similar. (auth) (UK)

21734 NUCLEAR RECOIL REACTIONS IN ORGANOMANGANESE COMPOUNDS. III. $Mn(CO)_5$. De Jong, I. G.; Srinivasan, S. C.; Wiles, D. R. (Carleton Univ., Ottawa). Can. J. Chem., 47: 1327-33(Apr. 15, 1969).

Experimental evidence is presented which shows that upon neutron irradiation of the compounds $Mn_2(CO)_{10}$, $CpMn(CO)_3$, and $CH_3CpMn(CO)_3$, where Cp is cyclopentadienyl, the recoiling ^{56}Mn atom gathers carbonyl radicals to stabilize itself in the group $Mn(CO)_5$, with about 10% radiochemical yield. Basically, the experiments involved addition of iodine to the irradiated compound and identification of the radioactive $IMn(CO)_5$ by carrier techniques. It is suggested that in $Mn_2(CO)_{10}$ targets, the species produced is the $Mn(CO)_5$ radical. Some experimental data are given to show that this radical is stable for over 1 hr in the solid at room temperature, but decomposes rapidly above about 60°. The radical decomposes in 20 to 30 sec in solution. In both other target compounds, the species produced is chemically more stable, although it reacts rapidly with iodine. This species is found to be $HMn(CO)_5$, which occurs to the extent of 10 to 12% in $CpMn(CO)_3$. $CH_3Mn(CO)_5$ was also detected in $CH_3CpMn(CO)_3$ targets, and its yield was found to be a function of the concentration of isooctane used as diluent in the targets. Results from other studies are discussed in the light of the present data, and it is concluded that in general, in neutron-irradiated metal carbonyl compounds, the recoil atom is able to accumulate carbonyl radicals to a greater extent than is consistent with the composition of the target compound. (auth) (Canada)

21735 RADIOLYTIC DECOMPOSITION OF CRYSTALLINE IODATES BY RECOIL PARTICLES. Hasegawa, Kunihiko. Nippon Kagaku Zasshi, 90: 135-8(Feb. 1969). (In Japanese).

The decomposition of IO_3^- in crystalline $LiIO_3$ by recoil energetic tritons and α particles accompanied by neutron capture of ^6Li, i.e., $^6Li(n,\alpha)^3H$ reaction, in the reactor was investigated. The radiolysis of the iodate was found to depend strongly on the linear energy transfer (LET). The initial 100-eV yield for $LiIO_3$ decomposition by recoiled particles, $G(-IO_3^-) = 2.85$, which was about three times larger than that obtained with ^{60}Co γ rays. The radiolytic decomposition of crystalline NH_4IO_3 in the reactor was also investigated. From the much greater yields observed it was assumed that the nuclear reactions such as $^{14}N(n,p)^{14}C$ and the elastic and inelastic collisions of fast neutrons with hydrogen, nitrogen, and oxygen atoms contribute largely to the radiolysis of this compound. (auth)

21736 MECHANISM OF THE FORMATION OF PARAMAGNETIC CENTERS IN γ-IRRADIATED SULFATES OF ALKALINE EARTH METALS. Barsova, L. I.; Ershov, B. G.; Popova, G. Yu.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk, SSSR, 184: 1124-7(Feb. 11, 1969). (In Russian).

The formation of paramagnetic centers was studied with specimens of $BaSO_4$ and $SrSO_4$ prepared by two different methods and irradiated by ^{60}Co γ rays with doses of 2×10^{16} eV at −196°C. The electron paramagnetic resonance spectra showed that the method and conditions of specimen preparation had a decisive effect on the yield and formation of paramagnetic centers as well as the thermal stability of the specimens. The radical SO_4^- in the specimen prepared by the first method and irradiated at −196°C remained stable up to 80°C and disappeared at 100 to 200°C. Concentration of paramagnetic centers in specimen 2 began at −140 to −130°, and at −100° 70% of radicals disappeared. The radiochemical yield of radicals in both specimens, irradiated at −196° was identical and equaled 4.0. However, at room temperature they were 3.8 and 0.7, respectively. Similar but less distinct effects of the methods of preparation were also observed in the specimens of $SrSO_4$. The differences in the yield and thermal stability of radicals in sulfate specimens may be the result not only of the effects of impurities on the structure of the crystal but also of their direct participation in radiolytic transformations. Experiments indicated that effective absorption energy transfer took place in chlorides of alkaline earth metals. The mechanism of transfer through mobile and free electrons and gaps was studied and results of the radiolysis of phosphates, carbonates, and other salts showed that the energy redistribution process uncovered in crystalline sulfates is universal. (R.V.J.)

21737 GAMMA RADIATION EFFECTS ON HOMOMOLECULAR EXCHANGE OF OXYGEN IN LANTHANUM OXIDE. Mitrofanova, G. N.; Sazonov, L. A.; Sokolovskii, V. D. (Inst. of Catalysis, Novosibirsk, USSR). Dokl. Akad. Nauk, SSSR, 184: 1152-4 (Feb. 11, 1969). (In Russian).

The homomolecular oxygen isotopic exchange reaction during irradiation was studied in order to determine the nature of the γ-radioinduced increase of the catalytic activity of rare earth oxides. Specimens of lanthanum carbonates containing 62% of the ^{18}O isotope mixed with natural isotopes were treated for 6 hr in a vacuum at 400°C and irradiated by 180 R/sec with a total dose of 0.6×10^6 R. The reaction rate during irradiation was tenfold faster than in the case of previously irradiated specimens. There was no indication that any special radiochemical processes had occurred. The tangent of the curve was slowly reduced in the previously irradiated specimens indicating the annealing of highly active centers. The experimental data also revealed that at low temperatures, when the rate of annealing is low, the rate of the reaction increased rapidly with the temperature. Thus, the increased activity of specimens during irradiation is assigned to the formation of centers even more active than the centers catalysing reaction in the post-irradiated specimens. (R.V.J.)

21738 NUCLEAR CHEMISTRY. Lefort, M. London, Van Nostrand Company, 1968. 531p. £5.

The subject is covered under the following main headings: Spontaneous disintegration and radioactive decay; types of nuclear disintegration; fundamentals of nuclear reactions; the compound nucleus reaction mechanism; high energy spallation reactions — direct interactions followed by particle evaporation; direct transfer of nucleons or clusters of nucleons in nuclear reactions (reactions with deuterons and heavy ions); nuclear fission at low energies; high energy fission (symmetric fission); experimental methods in nuclear chemistry; applications of nuclear chemistry; problems. (UK)

21739 ELECTRON PULSE RADIOLYSIS OF AQUEOUS TETRACHLORO AND TETRACYANO COMPLEXES OF Pt(II). Ghosh-Mazumdar, A. S.; Hart, Edwin J. (Argonne National Lab., Ill.). Int. J. Radiat. Phys. Chem., 1: 165-76(Apr. 1969).

The kinetic and spectral properties of transient Pt(I) and Pt(III) ions formed by the electron pulse radiolysis of $PtCl_4^{2-}$ and $Pt(CN)_4^{2-}$ in neutral, acid, and alkaline solutions are reported. With $PtCl_4^{2-}$, an absorption maximum attributed to Pt(I) occurs at 310 nm, while maxima for Pt(III) occur near 400 and 450 nm, although the position and intensity of these bands depend on the composition of the solutions irradiated. With $Pt(CN)_4^{2-}$ in acid solution, Pt(I) and Pt(III) both absorb at 295 nm. In alkaline solution a double peaked band with maxima at 295 and 360 nm exists for Pt(I) whereas the Pt(III) band is shifted to ≈305 nm. The decay kinetics of these bands are complex. Some rate constants in units of 1 mol^{-1} s^{-1} are: $(PtCl_4^{2-})$: $Pt(II) + OH \rightarrow Pt(III) + OH^-$ (8×10^9), $Pt(II) + e_{aq}^- \rightarrow Pt(I)$ (9.3×10^9); $(Pt(CN)_4^{2-})$: $Pt(II) + e_{aq}^- \rightarrow Pt(I)$ (4.2×10^9), $Pt(II) + OH \rightarrow Pt(III)$ (5.7×10^9). Because of its sensitivity and behavior toward N_2O and O_2, it is proposed that the Pt(I) species absorbing at 360 nm in irradiated $Pt(CN)_4^{2-}$ is an electron adduct. (auth) (UK)

21740 THE RADIATION CHEMISTRY OF CARBOHYDRATES. IX. FORMATION OF DEOXYSACCHARIDES DURING RADIOLYSIS OF AQUEOUS SOLUTIONS OF CELLOBIOSE AND LACTOSE. Kochetkov, N. K.; Kudryashov, L. I.; Yarovaya, S. M.; Bortsova, Z. I.; Chizhov, O. S. (Inst. of Organic Chemistry, Kazan). Zh. Obshch. Khim., 38: 2372-9(Nov. 1968). (In Russian).

The main products of the radiolysis of aqueous solutions of cellobiose and lactose were studied. In the absence of oxygen, reduction processes in the radiolysis of disaccharides led to the formation of 4-deoxysaccharides. In the radiolysis of glycosides a new type of deoxysaccharide was formed. (tr-auth)

21741 THE RADIATION CHEMISTRY OF CARBOHYDRATES. X. NEW DATA CONCERNING THE RADIOLYSIS OF AQUEOUS SOLUTIONS OF GLUCOSAMINE AND ITS DERIVATIVES. Kudryashov, L. I.; Senchenkova, T. M.; Nedoborova, L. I.; Kochetkov, N. K. (Inst. of Organic Chemistry, Kazan). Zh. Obshch. Khim., 38: 2380-3(Nov. 1968). (In Russian).

The effects of concentration on the decomposition of glucosamine and its derivatives were studied. At a concentration of 5×10^{-2}M, the character of the radiolysis of glucosamine (indexed as 2-amino-2-deoxyglucose) and N-acetylglucosamine (indexed as 2-acetamido-2-deoxyglucose) varies because of chain processes. The dependence of the decomposition of N-acetylglucosamine on radiation dose confirmed the postulation on the chain mechanism of the process. (tr-auth)

21742 THEORY OF THE RADIATION CHEMICAL YIELD. III. THE EFFECT OF MOLECULAR NATURE ON PRIMARY YIELDS. Santar, I.; Bednar, J. (Nuclear Research Inst., Prague). Collect. Czech. Chem. Commun., 34: 1-26(Jan. 1969).

Application of the theory of radiation chemical yield given in Part II (Collect. Chem. Commun., 33: 1(1968)) shows that the chemical nature of molecules substantially affects their primary radiolytic decomposition in the gas phase. Both fast (of kinetic energy $T \gtrsim 100$ eV) and slow ($T \lesssim 100$ eV) electrons of the degradation spectrum participate comparably in processes of the physical stage of radiolysis. The effect of slow electrons is, however, not entirely parallel to the "optical" effect of fast electrons so that the picture of primary radiolytic processes as deduced from optical spectra of molecules may be altered by slow electrons. (auth)

21743 RATE OF RADIOLYSIS OF THE DISULFIDE GROUPS OF CHYMOTRYPSINOGEN IN AQUEOUS SOLUTIONS EXPOSED TO X-IRRADIATION. Fojtik, A. (Inst. of Physical Chemistry, Prague); Brdicka, R.; Spurny, Z. Collect. Czech. Chem. Commun., 34: 158-67(Jan. 1969).

The macroscopic rates corresponding to inactivation of the disulfide groups in chymotrypsinogen (examined polarographically) obey first order kinetics with the average value of the formal overall constant 1.2×10^{-19} ml eV^{-1}, which is independent of the dose rate and the initial protein concentration. A model based on highly simplified assumptions is suggested in which the rate constant k represents an effective volume related to the dose unit chosen. The radius of this volume is taken equal to the sum of radii of the spur and the solute molecules. Using the experimental value obtained for the rate constant k of chymotrypsinogen, the radius of the effective volume amounts to about 100 Å. In addition, an indirect effect was noted which was ascribed to the interaction of primary radicals produced by ionizing radiation outside the effective volume with some other groups of chymotrypsinogen susceptible to attack. (auth)

21744 THEORY OF THE RADIATION CHEMICAL YIELD. IV. MOLECULAR POLARIZABILITY AND PRIMARY YIELDS. Santar, I.; Bednar, J. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 34: 311-15(Jan. 1969).

Equations are derived for studying the effects of the chemical nature of molecules on primary yields in radiation chemistry. The importance of the role of optical (dipole) oscillator strength, df/dE, in the theory of the primary radiation chemical yield is discussed. (P.C.H.)

21745 A METHOD FOR THE PRODUCTION OF SELF-SUPPORTING FILMS FROM UNSATURATED POLYESTER RESINS. (to N.V. Chemische Industrie Synres). British Patent 1,145,632. Mar. 19, 1969. Priority date July 8, 1966, Netherlands.

A method for the preparation of a self-supporting film from an unsaturated polyester resin comprises forming a film of the liquid unsaturated polyester resin dissolved in an unsaturated monomer with the film having an equivalence ratio of between 1.0 : 1 and 1.7 : 1 and irradiating the film with high-energy electrons having an energy greater than 1×10^8 erg/g of resin/sec. The irradiation lasts for less than 5 sec and serves to crosslink and solidify the film. (B.L.M.)

21746 THRESHOLD ENERGY FOR SUBSTITUTION OF T FOR D IN CD_4. Chou, C. C.; Rowland, F. S. (Univ. of California, Irvine). Contract AT-(11-1)-34. J. Chem. Phys., 50: 2763-4(Mar. 15, 1969).

The substitution of tritium for deuterium in CD_4 was observed. The wavelength of the absorbed light was varied to change the initial kinetic energy of photochemically produced tritium atoms. The CD_3T/DT ratio decreased from 0.062 at 2.8 eV to less that 0.01 at 1.9 eV. Below 1.5 eV the exchange reaction produced a negligible yield of CD_3T. (J.G.B.)

21747 PULSE RADIOLYSIS OF ORGANIC HALOGEN COMPOUNDS. I. DETECTION OF A SHORT-LIVED CHARGE TRANSFER COMPLEX WITH CHLORINE ATOMS. Buehler, Rolf E. (Federal Technical Univ., Zurich). Helv. Chim. Acta, 51: 1558-71(1968). (In German).

Pulse radiolysis experiments using 4-MeV electrons were carried out in a solution of benzene in carbon tetrachloride. A transient absorption in the visible part of the spectrum could be detected. It appeared within less than 0.3 μsec after irradiation by the electron pulse, and it could be shown to be due to the charge-transfer complex between the chlorine atoms as electron acceptors and benzene molecules as electron donors. A variety of aromatic hydrocarbons also yielded similar absorption bands in the visible region. They showed a linear correlation between the absorption energy and the ionization potential of the aromatic molecules, which is typical for charge-transfer complexes. A minimum value for the equilibrium constant of complex formation is given. The equilibrium is almost fully shifted to the complex side. The estimated G value for the charge-transfer complex indicated that the complex is actually part of a main reaction in the radiation-induced mechanism. The decay of the charge-transfer complex is mostly pseudo-first order with a half-life of a few microseconds. (BBB)

21748 RADIOLYSIS OF LIPIDS: MODE OF CLEAVAGE IN SIMPLE TRIGLYCERIDES. Dubravcic, M. F.; Nawar, W. W. (Univ. of Massachusetts, Amherst). J. Amer. Oil Chem. Soc., 45: 656-60(Oct. 1968).

The direct effects of ionizing radiation on model systems of triglycerides were studied. Trilaurin, trimyristin, tripalmitin, tristearin, tripalmitolein, triolein, and trilinolenin were γ irradiated (^{60}Co) under vacuum at 6 MRAD. The volatile breakdown products were separated by vacuum distillation and identified by gas chromatography and mass spectrometry. The radiolysis products of triglycerides were mainly hydrocarbons and some oxygen-containing compounds. Trilaurin, trimyristin, tripalmitin, and tristearin yielded normal alkanes and 1-alkenes. For each irradiated glyceride, 4 hydrocarbons were prominent. In all 4 triglycerides the dominant alkane had 1 carbon atom less and the principal alkene had 2 carbon atoms less than the parent fatty acid. In addition to hydrocarbons, irradiation of each saturated simple triglyceride produced 4 oxygen-containing compounds: a saturated and an unsaturated aldehyde containing the same numbers of carbons as the fatty acids present in the triglyceride, and also, the corresponding methyl and ethyl ester. Irradiation of triolein produced the normal alkanes C_1 to C_9, the normal 1-alkenes C_2 to C_{10}, the internally unsaturated alkenes C_{11} to C_{17}, and the alkadienes C_{11} to C_{17}. Radiolysis of triolein must have proceeded along a similar pathway to that of saturated triglycerides since the corresponding hydrocarbons were again formed in large quantities. Thus the production of the internally unsaturated heptadecene from triolein is analogous to the formation of heptadecane from tristearin and the production of hexadecadiene from triolein is analogous to the formation of 1-hexadecene from tristearin. Qualitative and quantitative data showed that the cleavage in fatty acids essentially followed a specific pattern and was not random. A mechanism of radiolysis was proposed. (BBB)

21749 POLYMERIZATION OF AMYLENES ON IRRADIATED AND NONIRRADIATED ALUMINOSILICATES THAT CONTAIN NICKEL OXIDES. Panchenkov, G. M.; Kozlov, L. L.; Kolesnikov, I. M.; Erchenkov, V. V.; Belousov, A. D. Zh. Fiz. Khim., 43: 131-4(Jan. 1969). (In Russian).

The polymerization of a mixture of amylenes was studied in the range from 20 to 80°C and for different times of contact with irradiated and nonirradiated aluminosilicate catalysts that contain nickel oxides. Irradiation of the catalyst by gamma rays led to a significant increase in the activity of the polymerization reaction. The formation of dimers proceeded according to an equation for a heterogeneous reaction of the second order. The activation energy for polymerization of amylenes on an irradiated catalyst was slightly below the activation energy on a nonirradiated catalyst. (tr-auth)

21750 CHEMICAL EFFECTS FOLLOWING THERMAL NEUTRON CAPTURE IN SOLID CHROMIUM(III) TRISACETYLACETONATE. Gainar, I.; Ponta, A. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 887-93(1968).

The primary distribution and the isothermal annealing behavior of ^{51}Cr-species in neutron-irradiated chromium(III) trisacetylacetonate were investigated. Three ^{51}Cr-species were detected: a parent, an ionic, and an unknown, probably an acetylacetone-deficient, one. The kinetics and the mechanism of the isothermal annealing are discussed. (auth)

21751 RADIOLYTIC PRODUCTS IN AQUEOUS OXALIC ACID DOSIMETER. Markovic, Vitomir; Bartonicek, Bohumil.

Bull. Boris Kidric Inst. Nucl. Sci., Chem., 19: No. 2, 5-11(June 1968).

Initial yields and complete dosage curves were obtained for carbon dioxide, hydrogen, formaldehyde, glyoxal, and hydrogen peroxide. The following compounds were not found among radiolytic products: carbon monoxide, glyoxylic acid, mesoxalic acid, glycolic, and formic acid. Evidence for 75% of the C atoms was found among measured products. Postreactions of some products (hydrogen peroxide, glyoxal) indicate the presence of some chemical reactions, which can occur simultaneously with the radiation chemical reactions. (auth)

21752 PAIRWISE TRAPPING OF RADICALS IN IRRADIATED HIGH POLYMERS AS STUDIED BY ELECTRON SPIN RESONANCE. Iwasaki, Machio; Ichikawa, Takahisa; Ohmori, Toshio (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys., 50: 1984-90(Mar. 1, 1969).

The $\Delta M_s = 2$ spectra due to radical pairs was observed in a number of typical polymers irradiated at 77°K. The formation of radical pairs is not a particular phenomenon in some particular crystalline solids. The crystallinity of the polymers does not affect the formation of radical pairs in an appreciable amount. The buildup curve of the radical pairs suggests that the pairwise trapping is not due to the occasional overlapping of the spurs and that there is an intrinsic value of formation. The hyperfine separation of the $\Delta M_s = 2$ spectra of polyethylene and polypropylene have values that are half of those of the isolated radicals. This means that the paired radicals are probably two alkyl radicals trapped in pair. The urea addition compounds of some polymers did not give any signal due to the $\Delta M_s = 2$ spectra. (auth)

21753 PAIRWISE TRAPPING OF RADICALS IN IRRADIATED n-HYDROCARBONS AND RELATED COMPOUNDS AS STUDIED BY ELECTRON SPIN RESONANCE. Iwasaki, Machio; Ichikawa, Takahisa; Ohmori, Toshio (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys., 50: 1991-7 (Mar. 1, 1969).

ESR signals due to radical pairs were found in *n*-hydrocarbons γ irradiated at 77°K. Besides the spectra due to the $\Delta M_s = 2$ transition, $\Delta M_s = 1$ spectra were also found on the tail of the predominant spectra of isolated radicals. The $\Delta M_s = 1$ spectra of the radical pairs show nearly the same hyperfine splitting as that of the $\Delta M_s = 2$ spectra. From the analysis of the $\Delta M_s = 1$ spectra, the separation $d_{\|}$ due to the zero-field splitting was determined to be 292 G from which the distance of the paired radicals was estimated to be 5.75 Å. The radical pairs are probably in the form of two alkyl radicals on the adjacent hydrocarbon chains. The value of 5.75 Å is consistent with the intercarbon distance between the adjacent chains aligned along the direction of the crystalline b axis. A glassy hydrocarbon such as squalane also gave the $\Delta M_s = 2$ spectrum but did not give the hyperfine lines on the tail of the $\Delta M_s = 1$ spectrum as in the case of high polymers. In addition, the effects of additives and substituents was also investigated together with some other related compounds and the mechanism of the pairwise formation of radicals is discussed. (auth)

21754 EFFECTS OF GAMMA RADIATION ON THE AMINO ACID COMPOSITION OF BOVINE PLASMA. Gambaruto, M.; Monesiglio, J. C.; Turjansky, L. Ind. Quim. (Buenos Aires), 26: 281-2(1968). (In Spanish).

The amino-acid composition of dry bovine plasma was measured by ion-exchange chromatography after acid hydrolysis. No significant change in the amino acid proportion was found when the dry plasma was exposed at room temperature to γ-radiation at dose levels of 0 to 2 MRads. Results indicate that the nutritional quality of dry bovine plasma is not impaired by doses of radiation at these levels. (auth)

21755 PRODUCTION OF ^{125}I FROM PILE-IRRADIATED XENON DIFLUORIDE. Kiss, I.; Groz, P.; Revesz, A.; Sipos, T. (Central Research Inst. for Physics, Budapest). J. Inorg. Nucl. Chem., 31: 1225-7(May 1969).

The essential feature of the method developed for the production of ^{125}I is that, instead of gas, a stable, solid compound of xenon, XeF_2, is used as target material. On irradiation with a thermal neutron flux of 2.5×10^{13} to 5.1×10^{13} in a WWR-S type nuclear reactor the final yield varied from 26 to 43 mCi ^{125}I/g of XeF_2 and the radioactive concentration of the product was 2–120 mCi/ml, with ^{126}I concentration below 1 per cent. In a batch run 50 g of XeF_2 was irradiated. (auth) (UK)

21756 THE PREPARATION OF ^{66}Ni. Pinajian, J. J. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 31: 1241-4(May 1969).

Mullicurie amounts of 55-hr ^{66}Ni were produced by utilizing a flux of 2.45×10^{15} n/cm^2/sec for the successive capture of neutrons by ^{64}Ni. Yields of 39 mc, 55 mc, and 66 mc of ^{66}Ni were obtained from 50 mg targets of 98.56 per cent isotopically enriched ^{64}Ni for 48-, 72-, and 96-hr irradiations, respectively. The ^{66}Ni was isolated as a purified product by precipitating the ^{110m}Ag contamination, electroplating the ^{66}Ni away from ^{24}Na, and by removing ^{58}Co and ^{60}Co by anion exchange chromatography. The cross section for the $^{64}Ni(n,\gamma)^{65}Ni$ reaction was remeasured in the ORR Reactor and the BSR Reactor by Lyon and Emery, and Lyon's original value of 1.5b was confirmed. Based on the present work the cross section for the $^{65}Ni(n,\gamma)^{66}Ni$ reaction is estimated to be 60 to 70b. (auth) (UK)

21757 SOME FEATURES OF RADIATION-CHEMICAL CONVERSIONS OF FLUOROOLEFINS. Volkova, E. V.; Zimakov, P. V.; Fokin, A. V. At. Energ. (USSR), 26: 240-5(Mar. 1969). (In Russian).

A study was made of the behavior of fluoroolefines, such as tetrafluoroethylene, trifluoroethylene, vinylidene fluoride, vinylfluoride, trifluorochloroethylene, hexafluoropropylene, and perfluoroisobutylene, under β and γ radiations. It is found that the main reaction of most of the fluoroolefines under irradiation is polymerization. The polymerization activity of the fluoroolefines depends on the structure and composition of the monomers. The experimental data obtained permit arrangement of the fluoroolefines studied by decreasing radiation polymerization rate in the following series: $CF_2 = CF_2 > CF_2 = CFH > CF_2 = CH_2 > CFH = CH_2 > CF_2 = CFCl > CF_2 = CF - CF_3 > CF_2 = C\begin{smallmatrix} CF_3 \\ CF_3 \end{smallmatrix}$. Some kinetic features were found for the radiation polymerization of fluoroolefines under heterogeneous conditions. (auth)

21758 RADIATION POLYMERIZATION FROM THE GASEOUS PHASE ON SOLID SURFACES AS A METHOD FOR PRODUCTION OF POLYMERS OF ISOTACTIC STRUCTURE (EXEMPLIFIED BY THE ACRYLIC ACID–POLYETHYLENE SYSTEM). Vlasov, A. V.; Malakhova, L. I.; Tsetlin, B. L.; Shablygin, M. V. (Inst. of Elemento-Organic Compounds, Moscow. All-Union Scientific Research Inst. of Synthetic Fiber, Mytishchi, USSR). Dokl. Akad. Nauk SSSR, 184: 843-6(Feb. 1, 1969). (In Russian).

Radiation polymerization from the gaseous phase onto solid surfaces was studied using stretched and non-stretched polyethylene films, gaseous acrylic acid, and x radiation. Infrared adsorption data confirmed the postulation that polymers with isotactic structure are produced, and that with thickening of the grafted layer the characteristics of the isotactic structure of the grafted polyacrylic acid become less pronounced. The data also indicated that with identical thickness of the grafted layer the degree of isotacticity of polyacrylic acid grafted to the non-stretched films is lower than that on stretched films. (R.V.J.)

21759 PULSE RADIOLYSIS OF NO: PRODUCTION OF NO_2 AND N_2O_3 AND THE PRODUCTION AND RELAXATION OF VIBRATIONALLY EXCITED NO. Hochanadel, C. J. (Oak Ridge National Lab., Tenn.); Ghormley, J. A.; Ogren, Paul J. J. Chem. Phys., 50: 3075-80(Apr. 1, 1969).

Radiolysis of NO with a 30-nsec pulse of 2-MV electrons produced absorption bands attributed to NO_2, N_2O_3, and vibrationally excited NO. In pure NO at 1 atm, most of the NO_2 formed during the pulse, but the formation of N_2O_3 was slower ($\tau = 0.3$ μsec). The NO_2 was produced by the reaction of O atoms with NO, and the pseudo-first-order rate constant for formation of NO_2 in an 11% NO–Ar mixture was slightly lower than that calculated from published values. The N_2O_3 came from the equilibrium $NO_2 + NO \rightleftharpoons N_2O_3$, which was achieved in <1 μsec, orders of magnitude faster than the previously estimated lower limit. The sum of yields of the two products (10.6 ± 0.5 molecules/100 eV) was independent of the pulse dose, but the ratio $G(NO_2)/G(N_2O_3)$ increased with dose. This can be explained by a shift in the above equilibrium caused by the temperature increase produced by the pulse. Superimposed on the broad N_2O_3 band in the ultraviolet was a sharp band at 2362 Å, indicating population of the first vibrational level of NO. The relaxation lifetime was 5.8 μsec for 13% NO in Ar and 1.6 μsec for 41% NO, giving a quenching probability by NO of $2.1 \pm 0.2 \times 10^{-4}$. A small amount of absorption in the (0, 2) band at 2472 Å decayed with a lifetime ~1.4 μsec, giving a probability for resonant vibration–vibration exchange of only $\sim 10^{-3}$. (auth)

21760 RADIATION INDUCED SOLID STATE POLYMERIZATION OF DERIVATIVES OF METHACRYLIC ACID. VI. POLYMERIZATION OF BARIUM METHACRYLATE DIHYDRATE DURING IRRADIATION. Bowden, M. J.; O'Donnell, J. H.; Sothman, R. D. (Univ. of Queensland, Brisbane). Makromol. Chem., 122: 186-95(Mar. 14, 1969).

Crystalline barium methacrylate dihydrate polymerized during γ-irradiation at 15 to 35°C. Sigmoidal shaped conversion curves were obtained. The induction period decreased markedly with increase in temperature or dose rate. The polymerization rate (approximately constant from 25 to 75% conversion) increased with dose rate, corresponding to an exponent of about 0.5, but was almost independent of temperature. ESR spectra showed that the radical concentration increased linearly with time from the commencement of irradiation giving G(radicals) = 7.6 ± 0.5 at 25°C and the same value at 15°C. The radical concentration decreased during the polymerization period, but then increased again. The induction period was attributed to physical trapping of short-chain propagating radicals. (auth)

21761 RADIOLYTIC BEHAVIOR OF SOLID MALONIC AND SUCCINIC ACIDS. Radak, B.; Petkovic, Lj.; Bartonicek, B. Bull. Boris Kidric Inst. Nucl. Sci., Chem., 19: No. 4, 21-9(Nov. 1968).

The radiolyses of malonic and succinic acids were studied in reactor-mixed radiation and in the pure gamma radiation field. The absorbed doses were between 10^8 and 10^9 rads and the corresponding conversions up to 50%. Acidimetry, gravimetry, gas-, paper-, and column chromatography were used for the analyses of irradiated samples. Both acids in both radiation fields were found to decompose so that each decomposed original molecule gave one CO_2 molecule and a less quantity of the fatty acid corresponding to the decarboxylated original one. Decomposition yields of the original compound decreased with an increasing number of C atoms in the molecule; the same was found for the main radiolytic products. Products with much lower G-values were also observed and quantitatively followed: CO, H_2, CH_4, C_2, H_6, formic, acetic, propionic, butyric, and valeric acids. Preliminary EPR measurements confirmed the existence of $HOO\dot{C}-CH-COOH$ radical in malonic acid, and $HOOC-\dot{C}H-CH_2-COOH$ and possibly a $R-C\begin{smallmatrix}{=}O\\ {-}\dot{O}\end{smallmatrix}$ radical in succinic acids. Results are compared with previously published data. The mass balance of the decomposition and products was established of 92% and 100% for malonic and succinic acid, respectively. Some requirements and trends of further investigation are pointed out. (auth)

21762 ESR-STUDIES ON X-IRRADIATED SALTS OF LEUCINE. II. RADICAL YIELD AND RADICAL KINETICS IN IRRADIATED L-LEUCINE-HCl. Damerau, W.; Lassmann, G. (Institut fuer Biophysik, Berlin). Biophysik, 5: 305-9(1969). (In German).

The free radical yield in L-Leucine · HCl following x-irradiation at room temperature is $G_R = 2.2$. The kinetic study shows more than one radical type. From the shape of the dose-yield-curve as well as the kinetics and the annealing behavior of the radicals after higher irradiation doses it is concluded that the stabilization of the radicals by the surrounding lattice is reduced with increasing accumulation of recombination products. (auth)

21763 HOT ATOM CHEMISTRY OF METAL CARBONYLS. THERMAL ANNEALING STUDIES IN CHROMIUM, MOLYBDENUM, AND TUNGSTEN HEXACARBONYLS. Zahn, U.; Collins, C. H.; Collins, K. E. (Technische Hochschule, Munich. State Univ. of New York, Buffalo). Radiochim. Acta, 11: 33-8(Mar. 1969).

The incorporation of recoil atoms into the parent species in neutron-irradiated chromium, molybdenum, and tungsten hexacarbonyls was determined as a function of absorbed dose, post-irradiation thermal treatment (−35° to 180°C), pre- and post-irradiation gamma treatment, and exposure to carbon monoxide atmospheres. The results are interpreted in terms of a mechanism in which carbon monoxide groups from individual activation events participate in reconstruction reactions at the recoil site or diffuse away from these sites. Bulk carbon monoxide molecules from radiolysis or from external carbon monoxide atmospheres also participate, though less efficiently, in the overall annealing process through long range diffusion. (auth)

21764 NEUTRON-IRRADIATED PHOSPHORUS TRIBROMIDE AND ITS HYDROLYSIS PRODUCTS. Teague, J. L.; Sandoval, A. A. (Univ. of Missouri, Kansas City). Radiochim. Acta, 11: 57-8(Mar. 1969).

Results of an investigation of the products resulting from the neutron irradiation of PBr_3 and PCl_3 showed that in addition to the usual hydrolysis products a radioactive species was produced that was eluted from the ion exchange column in the second and third fractions. This corresponds in position of elution to the compound P_2H_4 reported previously in the hydrolysis products of P_2Cl_4 and P_2I_4. The exposure of neutron-irradiated PBr_3 samples to an uv source for approximately 20 hr resulted in a greatly decreased amount of $^{32}PPH_4$ appearing in the hydrolysate. From comparative studies of the hydrolysis of neutron-irradiated PBr_3 and PCl_3 it was concluded that $^{32}PPBr_4$ is indeed likely to be produced during the neutron irradiation of PBr_3. (D.H.M.)

21765 ^{99m}Tc PRODUCTION BASED ON THE EXTRACTION WITH METHYL-ETHYL KETONE. Belkas, E. P.; Perricos, D. C. (Democritus Nuclear Research Center, Athens). Radiochim. Acta, 11: 56-7(Mar. 1969).

A method for the production of ^{99m}Tc based on the quantitative extraction of Tc with methyl ethyl ketone (indexed as 2-butanone) from a sodium hydroxide solution of irradiated Mo is presented. Experiments were performed to study the extraction as a function of NaOH, molybdenum concentration, and extraction time. Results show that ^{99m}Tc is very extractable throughout the whole range of basicity studied, 0.5 to 20 M NaOH, while Mo is not, the extraction of Te was independent of the amount of Mo present in the range of concentrations studied (0.13 to 1.3 g of inactive Mo per ml of aqueous phase), and an extraction time of 3 to 5 min was sufficient. An apparatus is described for the extraction of Tc from neutron-irradiated Mo which can be easily and rapidly operated by remote handling. The extraction efficiency was about 99% and the purity of ^{99m}Tc was better than 99.99%. (D.H.M.)

21766 HYDROCARBON FORMING PATHWAYS FROM AMINE DIAZOTIZATIONS. Friedman, Lester; Jurewicz, Anthony T. (Case Western Reserve Univ., Cleveland). J. Amer. Chem. Soc., 91: 1803-8(Mar. 26, 1969).

Diazotization of several deuterium-labeled isobutyl- and sec-butylamines in protic and aprotic solvents gave hydrocarbon mixtures containing methylcyclopropane. The deuterium content of the methylcyclopropanes suggests that a minor amount (~2%) of the methylcyclopropane arises via a partially equilibrating protonated methylcyclopropane. From the dueterium content of isobutylene it is possible to calculate the extent of hydride shift to t-butyl cation in its formation. Rearrangement (1,2-hydride shift) of sec-butyl cation obtained from isobutylamine via a 1,2-methyl shift was found to be solvent dependent. Possible explanations for this phenomenon are considered. (auth)

21767 THE PHOTODECOMPOSITION OF CH_2O, CD_2O, CHDO, AND CH_2O–CD_2O MIXTURES AT XENON FLASH LAMP INTENSITIES. McQuigg, Robert D.; Calvert, Jack G. (Ohio State Univ., Columbus). J. Amer. Chem. Soc., 91: 1590-9(Mar. 26, 1969).

The volume and composition of the gaseous products of the photolyses of the pure formaldehydes, CH_2O, CD_2O, and CHDO, and mixtures of CH_2O and CD_2O were determined in experiments at various xenon flash lamp intensities, pressures of aldehyde, temperatures, and at selected wavelength regions of the aldehyde absorption. The data are consistent with the occurrence of two primary photodissociative processes, $CH_2O^* \rightarrow H + HCO$ (I) and $CH_2O^* \rightarrow H_2 + CO$ (II), and the dominance of radical–radical reactions following process I for these conditions. In CH_2O, $\phi_I + \phi_{II} \cong 1.0$ over the entire absorption band; for CD_2O and CHDO the sum is less than unity at the long-wavelength region. From the H_2, HD, and D_2 product distribution in CH_2O–CD_2O mixture photolyses and from the photolyses of CHDO, it was found that the relative efficiencies of processes I and II show a marked dependence on the wavelength of absorbed light; ϕ_I/ϕ_{II} varies from near zero at the longest wavelengths (3550 Å) to a value over unity at the shortest wavelengths employed in this work (2800 Å). On the basis of certain reasonable assumptions concerning the mechanism of the secondary reactions, estimates were derived for ϕ_I and ϕ_{II} for each major absorption band for CH_2O and CD_2O. The temperature and pressure independence of the ϕ_I/ϕ_{II} estimates from the photolyses limited to the long-wavelength bands of formaldehyde shows that process III, $CH_2O^* + CH_2O \rightarrow CH_2OH + HCO$, is unimportant for these conditions. Although process II is the dominant mode of formaldehyde photodecomposition for these conditions, process I does not occur measurably on the absorption of light by formaldehyde vapor in the band near 3385 Å. From these observations it is concluded that $D_{HCO\text{-}H} \leq 85$ kcal/mole. (auth)

Radiochemistry

21768 CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS OF COMPLEXED METAL ATOMS. I. THE BETA-DECAY OF ^{144}Ce AND ^{143}Ce COMPLEXED WITH POLYAMINOPOLYCARBOXYLIC ACID CHELATING LIGANDS. Glentworth, P.; Wright, C. L. (Univ. of Leeds, Eng.). J. Inorg. Nucl. Chem., 31: 1263-82(May 1969).

The chemical effects of beta-decay of ^{144}Ce and ^{143}Ce complexed with polyaminopolycarboxylic acid chelating ligands were further investigated. The extent of decomposition of the daughter complexes produced by beta-decay of ^{144}Ce and ^{143}Ce complexed, in aqueous solution, with the multidentate ligand DTPA was determined. A marked difference in the effects of beta-decay was observed for the two isotopes. A value of 89 ± 10 per cent, independent of pH, was determined for the percentage break-up of the daughter complex produced by beta-decay of $^{143}Ce(DTPA)^{2-}$, in contrast with the previously determined, pH dependent values, of between 30.9 ± 1 per cent and 66.3 ± 5.0 per cent for the

^{144}Ce(DTPA)$^{2-}$ complex ions. The percentage break-up values were calculated by a comprehensive treatment of results which makes allowance for associated isotopic exchange processes. A mechanism is proposed that accounts for the different behavior of the two cerium isotopes in terms of the positive charges acquired by the praseodymium daughter atoms as the result of the internal conversion of γ rays and electron "shake-off" processes. (auth) (UK)

21769 ELECTRIC CHARGE OF RADIOACTIVE SUBSTANCES. Gromov, V. V. At. Energ. (USSR), 26: 250-2(Mar. 1969). (In Russian).

Analyses were made of arising and distribution of electric charges on the surfaces of radioactive ionic crystals. A formula was derived for calculation of the charge resulting from radioactive decay (emission of the charged particles β^-, β^+, α). Radioactive dielectrics have a doubly charged layer at the surface. Experimental values for this charge on radioactive metals agree with the calculated ones. (auth)

21770 CHEMICAL EFFECTS ASSOCIATED WITH β^- EMISSION. I. STUDY OF THE ^{77}As FORMED BY THE β^- DISINTEGRATION OF ^{77m}Ge AND ^{77}Ge in GeO$_2$ IRRADIATED IN A NUCLEAR REACTOR. Genet, Michel; Ferradini, Christiane (Institut de Physique Nucleaire, Paris). Radiochim. Acta, 11: 19-25(Mar. 1969). (In French).

Arsenic-77 was formed by irradiation of GeO$_2$ in a nuclear reactor. The distribution between ^{77}As(III) and ^{77}As(V) was studied and was found to depend on the conditions of analysis (pH, presence of carriers, dissolved oxygen) and on the treatment of the solid. The quantity of ^{77}As(III) found by analysis increased to a limiting value with an increase of the amount of inactive arsenite present at the moment of dissolution of the GeO$_2$ in a basic medium. Preliminary outgassing of the solution or a diminution of pH also tended to protect the trivalent state of the radioarsenic. Under standard conditions of analysis, the amount of ^{77}As(III) found was 85%. The figure can be increased to 92% by heating the solid before activation in a nuclear reactor. It can be decreased to 35% by thermal annealing after irradiation. Irradiation by γ rays after annealing tends to annul the effect of the latter. (auth)

21771 THERMAL ANNEALING OF ^{127}Te ATOMS IN ^{127m}Te-LABELLED SODIUM TELLURATE. Halpern, A.; Dancewicz, D. (Inst. of Nuclear Research, Warsaw). Radiochim. Acta, 11: 31-3 (Mar. 1969).

Valence distribution of ^{127}Te atoms resulting from the isomeric transition in ^{127m}Te-labeled sodium tellurate and the post-decay isothermal annealing were studied. No effect on either the initial valence distribution or on the annealing process was observed which could be attributed to the concentration of lattice defects. (auth)

21772 CHEMICAL EFFECTS ASSOCIATED WITH β^- EMISSION. II. STUDY OF THE ^{77}As FORMED BY THE β^- DISINTEGRATION OF ^{77}Ge IN SYNTHETIC ^{76,77}GeO$_2$. Genet, Michel; Ferradini, Christiane (Institut de Physique Nucleaire, Paris). Radiochim. Acta, 11: 25-30(Mar. 1969). (In French).

The distribution of ^{77}As between the valence states III and V was studied. This radioarsenic is formed by β disintegration (outside of the nuclear reactor) in germanium oxide labeled with ^{77}Ge (synthetic ^{76,77}GeO$_2$). Whatever the conditions of analysis (pH, presence of carriers, or dissolved oxygen), the distribution 40% ^{77}As(III), 60% ^{77}As(V) is always obtained. When disintegration takes place at room temperature, no thermal annealing of radioarsenic is observable, even at 300° or 400°C. On the other hand, if ^{76,77}GeO$_2$ is heated during the entire time of disintegration, oxidation of ^{77}As(III) to ^{77}As(V) is observed: at 450°C the distribution, 6% ^{77}As(III) and 94% ^{77}As(V) is obtained. Irradiation of ^{76,77}GeO$_2$ by γ rays during or after the disintegration reduces ^{77}As(V) with a yield, $G(-^{77}\mathrm{As(V)}) = (3 \pm 1)\ 10^{-5}$. Thus, for large doses, one obtains 90% ^{77}As and 10% ^{77}As(V). After this irradiation, thermal annealing of radioarsenic can be observed. The results are interpreted by assuming the formation of Ge(II) in GeO$_2$ under irradiation (γ or reactor). It may then be shown that 50% of the radioarsenic in GeO$_2$ can be oxidized by thermal annealing and reduced by gamma irradiation. The following distribution is thus envisaged: 35% ^{77}As(III) unoxidizable; 50% ^{77}As polyvalent; and 15% ^{77}As(V) irreducible. The distribution depends on the crystallinity of the GeO$_2$ and seems to be independent of the recoil energy of ^{77}As. When irradiated GeO$_2$ is dissolved, Ge(II) reacts with oxygen in solution to form H$_2$O$_2$ (2×10^{-5} M under our conditions). The oxidation of As(III) by H$_2$O$_2$ depends on the pH, and it is thus possible to account for the effect of carriers, pH and dissolved oxygen. (auth)

21773 IODINE ORGANIC YIELDS IN HYDROCARBON MATRICES AS AN INDICATION OF CLUSTERING, COMPLEXING, AND FRACTIONAL CRYSTALLIZATION AT 77°K. Ayres, R. L.; Kemnitz, E. J.; Lambrecht, R. M.; Rack, E. P. (Univ. of Nebraska, Lincoln). Contract AT(11-1)-1617. Radiochim. Acta, 11: 1-4(Mar. 1969). (COO-1617-7).

The organic yields of iodine resulting from the ^{127}I (n, γ)^{128}I, and, in some instances, the ^{129}I (n, γ)^{130}I + ^{130}I^{m} and the ^{130}I^{m}(IT)^{130}I reactions in n-hexane, cyclohexane, and benzene were studied as a function of I$_2$ concentration. Under the conditions of monomolecular dispersion, the three structurally dissimilar hydrocarbons showed approximately equal preference for either organic or inorganic combination. Constant organic yields in cyclohexane and n-hexane between 0.001 and 0.02 mole percent I$_2$ indicate the formation of preferred (I$_2$)$_n$ cluster sizes and/or similar numbers of iodine molecules at sites in the polycrystalline organic matrices. The solid state organic yields are independent of isotope and mode of activation. Various repurification procedures and additives were employed to determine the necessary and sufficient procedures required to obtain meaningful experimental data. (auth)

Separation Processes

Refer also to abstracts 23848–23856 and 23935.

21774 (BNWL–1003) RESEARCH AND DEVELOPMENT ACTIVITIES FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, November 1968–January 1969. Platt, A. M. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1969. Contract AT(45-1)-1830. 55p. Dep. CFSTI.

Spray solidification Run SS-6 was completed by reducing 986 liters of sulfate-free PW-1 waste to 65 liters of ceramic solid in 55.6 hr. The 3,030,000 Ci of radioactivity interfused in the solidified waste produced an internal heat generation rate of 10,800 W. During spray solidification Run SS-7, 839 liters of PW-1 waste containing 3,620,000 Ci of radioactivity were reduced to 64 liters of ceramic solid in 47 hr. The solidified waste produced an internal heat generation rate of 12,700 W, which represents the maximum internal heat generation rate in any WSEP receiver pot to date. The centerline and wall temperatures of the receiver pot while hanging in air were 928 and 427°C, respectively, representing a thermal maximum in air. A PW-4m phosphate feed suitable for spray solidification was developed and tested in the cold semiworks spray solidifier. It was necessary to dilute the feed to 585 liters/tonne to achieve adequate feed flow control. In two additional runs, ruthenium volatilization was shown to increase with feed acidity and essentially no ruthenium volatilized at a feed acidity near zero. A radioactive WSEP waste pot was installed in an environmental test pot in the Solids Storage Engineering Test Facility (SSETF) to begin the interim storage studies. The first pot is from phosphate glass Run PG-4 and currently contains 2.2 kW of fission product decay heat. (auth)

21775 (CEA-R–3678) RADIOCHEMICAL SEPARATIONS OF HAFNIUM, TANTALUM, AND GERMANIUM FROM TUNGSTEN AND SELENIUM IRRADIATED BY 14-MeV NEUTRONS. Blachot, Jean; Benabed, Abderrahmane; Herment, Jacques; Monnand, Edouard (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec. 1968. 11p. (In French). Dep.

Radiochemical separations of Hf and Ta from W and Ge from Se after 14-MeV neutron irradiation are described. ^{79}Ge with a half-life of 50 ± 5 sec and an emitter of a 230-keV γ transition was observed. (auth)

21776 (KFK–802) USE OF STATISTICAL ANALYSIS FOR THE ESTABLISHMENT OF MATERIAL BALANCE IN A REPROCESSING PLANT. Gmelin, W.; Gupta, D.; Haefele, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Oct. 1968. 23p. Dep.

Two possibilities for reducing the work necessary to carry out a fissile material balance in a reprocessing plant were analyzed. The first possibility deals with the compositing of individual samples obtained from tanks or containers at different strategic points for determination of the fissile material content. The second one deals with the use of data obtained by the operator himself for determination of the fissile material balance in the plant. Possible applications of the two methods are shown with the help of numerical examples. The operator's data can be used if the data are controlled by the reliance of the first and second type, if the required standard deviation for the test is guaranteed, and if the measures to be taken in case the data from the operator deviate significantly from those of the controller are clarified. (M.C.G.)

21777 (MLM–1531) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT: OCTOBER–DECEMBER 1968. (Mound Lab., Miamisburg, Ohio). Apr. 7, 1969. Contract AT(31-1)-Gen-53. 25p. Dep. CFSTI.

The residue adsorption separation of ^{227}Ac from ^{227}Th was investigated with a variety of metathesis and desorption reagents. A tentative sequential separation of ^{227}Ac, ^{227}Th, and ^{223}Ra is described. ^{137m}Ba can be separated from ^{137}Cs by desorption with dilute NH_4OH from a phosphate residue. A 0.54-g sample of purified ^{234}U was analyzed by calorimetry and a half-life value of 240,200 yr was calculated. Purified ^{206}Pb totalling 260 mg from the alpha decay of ^{210}Po is on hand. An additional 1.55 g of ^{206}Pb was decontaminated to a ^{210}Po content of 8 μCi and is being further decontaminated. Specimens of irradiated bismuth from which the ^{210}Po was extracted were obtained and the ^{210m}Bi isomer was enriched by calutron separation techniques. The alpha spectrum of ^{210m}Bi in general was reported previously. Data were obtained that make it possible to specify the alpha decay branching with good precision. It was also shown that the alpha decays of ^{210}Bi preferentially populate the levels in ^{206}Tl at 266 and 305 keV. It was found that 100 ppM of tellurium enhances the absorption of bismuth, nickel, and chromium in the atomic absorption determination of these elements in $1\underline{M}$ HCl. Increasing amounts of tellurium in the presence of a constant concentration of the element determined also lead to increased absorption. The feasibility of successfully eluting thorium β-diketones using gas chromatography was determined using thermogravimetric curves. (auth)

21778 (NUMEC-1661-3) RECOVERY OF PLUTONIUM FROM ZPPR UNMEASURABLE WASTES. Semiannual Progress Report No. 3, August 1, 1968–January 31, 1969. Garber, Harold J. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Mar. 14, 1969. Contract AT(1-11)-1661. 95p. Dep. CFSTI.

The concept of combination of selective incineration, wet chemical reprocessing, and direct burial disposal is developed and its economic aspects discussed. A description of the incineration facility is given. Detailed technical information is given on the thermal and mass quantities involved in the facility design. An outline of specifications is given for the key components of the main equipment sections of the Incineration Facility. (J.C.W.)

21779 (ORNL-TM-2170) HOT-CELL STUDIES OF THE FLUIDIZED-BED FLUORIDE VOLATILITY PROCESS FOR RECOVERING URANIUM AND PLUTONIUM FROM SPENT UO_2 FUELS. Mailen, J. C.; Cathers, G. I. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 35p. Dep. CFSTI.

Bench-scale experiments with UO_2 irradiated to a burnup of 34,000 Mwd/metric ton and cooled for two years were performed, using a 0.94-in.-ID fluidized-bed reactor. The objectives of these experiments were to test NaF at 400°C for use as a trap for volatile fission product fluorides, to test MgF_2 for use as a trap for neptunium and technetium fluorides, to test NaF at 550°C for use as a trap for sorbing PuF_6 and separating it from ruthenium, to study the behavior of neptunium, and to determine the fate of tritium. In these studies the UO_2 was first oxidized with 20% O_2–80% N_2 at 450°C, to form U_3O_8; this was then treated with BrF_5–N_2 mixtures (5 to 10% BrF_5) at 300°C to form UF_6 and volatilize the uranium and most of the ruthenium, molybdenum, and technetium fluorides; finally, treatment with fluorine at 300 to 500°C was used to fluorinate and volatilize the plutonium as PuF_6. In some runs, BrF_3 was used for a final cleanup of uranium after the BrF_5 treatment. Plutonium was separated from the fluorine stream, by irreversible sorption on NaF, in a trap at temperatures above 500°C. Uranium hexafluoride was purified by passage through a 400°C NaF bed and by sorption on, and desorption from, NaF. A ruthenium decontamination factor of 2000 was obtained by using a 400°C NaF bed and a residence time of 15 sec; cosorption of ruthenium in the plutonium trap was minimized by operating it at 550 to 600°C. Of the tritium in the fuel, about 95% was liberated during the heatup of the fuel to 450°C and during the oxidation; the other 5% was liberated during the BrF_5 step. (auth)

21780 (ORNL-TM-2522) SOLVENT EXTRACTION OF URANIUM FROM WET-PROCESS PHOSPHORIC ACID. Hurst, F. J.; Crouse, D. J.; Brown, K. B. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 49p. Dep. CFSTI.

A large number of reagents were screened, in laboratory tests, for possible use as extractants for recovering uranium from commercial wet-process phosphoric acid. Results indicated that the synergistic extraction combination of di(2-ethylhexyl) phosphoric acid plus trioctylphosphine oxide in a kerosene-type of diluent was sufficiently promising to merit further evaluation. Although the uranium extraction coefficients for this combination are not high, they are adequate for effective process application. On the basis of the results of batch tests, a tentative flowsheet was outlined that appears to have several advantages over the process previously used for the recovery of uranium from wet-process acid. For example: the synergistic extractant is stable and can be recycled extensively; the uranium is extracted in its hexavalent state, which avoids the expensive reduction step with iron metal; the uranium is easily stripped from the solvent with solutions of ammonium carbonate; and the product obtained is relatively high-grade and is easy to handle in subsequent purification processes. The chief disadvantage of the new process is the relatively high cost of the extractant. In process applications, it would be necessary, therefore, to operate with a comparatively low loss of the extracting solvent. Engineering studies will be required to evaluate this and other operational variables. (auth)

21781 (ORNL-TM-2552) AQUEOUS PROCESSING OF LMFBR FUELS. Progress Report, No. 1, March 1969. Unger, W. E.; Blanco, R. E.; Watson, C. D.; Crouse, D. J.; Irvine, A. R. (comps.) (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 46p. Dep. CFSTI.

Progress in the development of aqueous methods for the reprocessing of LMFBR fuels is outlined. Development work is reported on problems of irradiated fuel transport to the processing facility, dissolution of the fuel and chemical recovery of the PuO_2–UO_2 values, the containment of volatile fission products, and product purification for subsequent reconstitution into reactor fuel. Pertinent experimental results are presented for the information of those immediately concerned with the field. (auth)

21782 METHOD OF PRODUCING GASEOUS HEAVY HYDROGEN ISOTOPES AT SUPERATMOSPHERIC PRESSURE. Vit, J.; Prochazka, V.; Mamula, M.; Matys, V. (to Ceskoslovenska Akademie Ved). Canadian Patent 799,892. Nov. 26, 1968.

Methods are described for producing D and T under pressure on a laboratory scale by the reaction of heavy water or tritiated water on several metals in a pressure vessel. Na, Zn, and Al, are among the metals named. Conditions for initiating the reaction are detailed and also the substances present when the reaction is finished. A table shows the yield expected with various metals or mixtures of them. Eleven sample reactions with parameters are described. (F.S.A.)

21783 CHROMATOGRAPHIC SEPARATION OF STRONTIUM FROM BARITES FOR MASS SPECTROMETRIC ANALYSIS. Kalra, Ashok K. (Univ. of British Columbia, Vancouver). Mikrochim. Acta, No. 2, 393-6(1969).

A simple chromatographic method for the separation of strontium in barites containing 500 times excess barium is described. The strontium fraction is sufficiently pure for mass spectrometer studies of strontium isotopes. The resin used is Dowex-50 and the column dimensions are 1.1 by 8 cm. The column is eluted at room temperature with $1.5\underline{M}$ hydrochloric acid at a flow rate of ~1 ml/min. The effect of column temperature on the elution peaks is pointed out. (auth)

21784 STUDY OF THE SORPTION OF IONS OF HEAVY METALS BY PHOSPHATE SORBENTS BY INFRARED SPECTROSCOPY. II. SPECTRA OF PHOSPHATE SORBENTS SATURATED BY URANIUM. Paramonova, V. I.; Nikitina, G. P.; Akopov, G. A. Radiokhimiya, 10: 646-53(1968). (In Russian).

On the basis of studies of the spectra of phosphate resins with different degrees of uranium saturation it was established that, on sorption of uranium from acetatonitrate solutions by phosphate cation exchangers, only the UO_2^{2+} ions are sorbed with the formation of additional coordination bonds with phosphoryl oxygen atoms. Possible structures of complex compounds, formed on interaction of uranyl ions with functional groups of the phosphate resins, are proposed. (tr-auth)

21785 INFLUENCE OF PROCESSES OF COMPLEX FORMATION ON THE SORPTION OF IONS OF HEAVY METALS BY PHOSPHATE SORBENTS. Paramonova, V. I.; Akopov, G. A.; Kochevanova, L. A. Radiokhimiya, 10: 653-62(1968). (In Russian).

The sorption of uranium by different phosphate resins from acetate solutions was studied. It was established that, with a decrease in the concentration of free acetate ions in solution, the coefficient of distribution of the uranium between the resin and the solution is increased. Constants of uranyl–sodium exchange on phosphate resins at pH = 4.0 and 2.35 on sorption of their acetate and nitrate solutions were established. It was also found that the uranyl ion reacts with two functional groups of the phosphate resin. In addition, sorption proceeds according to an ion-exchange mechanism. The stability of uranyl complexes with the functional groups of phosphate resins was established. (tr-auth)

21786 SOLVENT EXTRACTION PRODUCTION OF HIGH SPECIFIC ACTIVITY ^{59}Fe AND CARRIER FREE ^{54}Mn FROM IRRADIATED IRON TARGETS. El-Garhy, M.; El-Reefy, Sohair A.; Allan, A. (Atomic Energy Establishment, Cairo). Mikrochim. Acta, No. 2, 280-5(1969).

Three different procedures were developed for the production of ^{59}Fe and ^{54}Mn from irradiated iron targets using tridodecylamine, tributyl phosphate, and isobutyl methyl ketone, indexed as 4-methyl-2-pentanone. These procedures are simpler and more economical than those previously reported. The yield as estimated by the standard addition technique was found to be always higher than 90%. The separated isotopes were found to be very pure radiochemically. (auth)

21787 ALKALINE PROCESSING OF SOME URANIUM ORES. Bunus, Fl.; Matei, I.; Sporea, V. Rev. Chim. (Bucharest)., 20: 19-24(Jan. 1969). (In Rumanian).

A series of experiments were carried out on uranium ores of a basic character. The aim was to determine the optimum conditions for attacking the ore, using the alkaline processing procedure with sodium carbonate. Extraction yields of a high uranium content were obtained, proving the ore to be suited for industrial processing. During the laboratory work the existence, in the solid phase, of some components having an adsorbing character was established. The inefficiency of the copper-ammonia complex for catalyzing the oxidizing reaction was established. (auth)

21788 SEPARATION OF ACTINIUM AND THORIUM FROM URANIUM AND ITS DAUGHTERS. Swanson, Donald H. (to United States Atomic Energy Commission). U. S. Patent 3,434,809. Mar. 25, 1969.

A method was developed for separation of actinium and thorium from a solution of uranium and its decay products. A cation exchange resin is loaded with a solution including uranium, actinium, thorium, and other uranium decay products cations, eluting cations other than thorium and actinium with a dilute acid solution, separately eluting thorium with an ammonium salt solution, and eluting actinium with a solution of strong acid or ammonium salt. (AEC)

21789 PLUTONIUM SUBLIMATION. Chilenskas, Albert A. (to United States Atomic Energy Commission). U. S. Patent 3,436,193. Apr. 1, 1969.

A process was developed, in which plutonium hexafluoride is separated from volatile fission product fluorides by freezing the fluorides and subliming the plutonium hexafluoride from the solid. (AEC)

21790 SOLVENT EXTRACTION OF NIOBIUM AND TANTALUM. VII. EXTRACTION WITH DI-n-OCTYLAMINO ALCOHOLS FROM OXALIC SOLUTIONS. Djordjevic, C.; Gorican, H.; Sevdic, D. (Univ., Zagreb. Inst. Rudjer Boskovic, Zagreb). J. Inorg. Nucl. Chem., 31: 1487-94(May 1969).

Studies were made on the extraction of niobium and tantalum with di-n-octylamino ethanol (DOAE) and di-n-octylamino propanol (DOAP) from oxalic solutions in the presence of mineral acids, and the amine/metal ratio was determined in the organic phase (chloroform). The same ratio for both metals was observed, varying from 3 : 1 to 1 : 1, dependent upon the composition of the aqueous phase. Extracting species of niobium and tantalum were separated under different conditions, and characterized by analysis and ir spectra. The ir spectra of the organic phases were examined and compared with the spectra of the separated substances. On the basis of this evidence the mechanism of the oxalato niobate and tantalate extraction with these N-substituted long chain amino alcohols was deduced, and this mechanism proved to be of the ion association type. (auth) (UK)

21791 SODIUM AND STRONTIUM EXTRACTION FROM SODIUM NITRATE SOLUTIONS BY n-OCTANE SOLUTIONS OF A BRANCHED ALIPHATIC MONOCARBOXYLIC ACID: MECHANISMS AND EQUILIBRIA. McDowell, W. J.; Harmon, H. D. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 31: 1473-85(May 1969).

Sodium and strontium were extracted from 5.0 M $NaNO_3$ solutions by n-octane solutions of a highly branched aliphatic carboxylic acid (RR′R′′CCOOH), which was a fraction distilled from a developmental mixture "Versatic Acid 1519." From the dependence of the extraction on pH and extractant concentration, from extractant and extract aggregation in the organic phase, and from ir absorption studies of the complexes present in the extract, the most probable extraction reactions are $Na^+ + 1.5(HA)_2 \rightleftharpoons NaA \cdot 2HA + H^+$ and $Na^+ + 2(HA)_2 \rightleftharpoons NaA \cdot 3HA + H^+$ and $Sr^{2+} + 2(HA)_2 \rightleftharpoons SrA_2 \cdot 2HA + 2H^+$ and $Sr^{2+} + 2.5(HA)_2 \rightleftharpoons SrA_2 \cdot 3HA + 2H^+$. The carboxylic acid extraction of sodium and strontium from sodium-salted systems is, in several ways, similar to di(2-ethylhexyl)phosphoric acid (HDEHP) extraction of these ions. Similar salt-plus-coordinated-acid complexes are formed, resulting in the curves of strontium extraction coefficient vs pH having the same general shapes and well defined maxima. The maximum strontium extraction coefficients and separation factors from sodium were almost 100 times greater with this carboxylic acid than with HDEHP. Maximum extraction with the carboxylic acid occurs, however, at pH 8.5 to 9.5 while with HDEHP it occurs in the pH range 5 to 6. Thus, the advantage in extraction coefficient may be limited to the more basic ions. (auth) (UK)

21792 LIQUID-LIQUID EXTRACTION OF MANGANESE, CHROMIUM, AND THORIUM BY LONG-CHAIN AMINES FROM CONCENTRATED HALIDE MEDIA. Florence, T. M.; Farrar, Yvonne J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aust. J. Chem., 22: 473-6(Feb. 1969).

A study was made of the extraction of manganese(II), chromium(III), and thorium(IV) by a long-chain tertiary amine (Alamine 336) from aqueous and methanolic halide media. All three metals extract well if the halide concentration is sufficiently high and the free acidity low. The extraction of manganese and thorium decreases in the order LiCl > LiBr > LiI, whereas the reverse order is true for chromium. The effects of amine diluent and halide cation on the distribution ratios were investigated. (auth) (Australia)

21793 PROCESS AND MATERIAL FOR EXTRACTING DISSOLVED RADIOACTIVE IONS FROM LIQUIDS. (to Sartorius-Membranfilter GmbH). British Patent 1,146,794. Mar. 26, 1969. Priority date July 11, 1966, Germany.

An ion-exchange type process is described for extracting radioactive ions from liquids by passing the liquids through a column in contact with a micro-crystalline, difficultly soluble salt containing nonradioactive ions that are isotopic with the dissolved radioactive ions. The salt is bonded to a support that is either soluble in an organic solvent or that is combustible so that the radioactive material can be concentrated in a small volume when the exchange is complete. The exchange material is prepared by precipitation of the salt on the surface of the support in an agitated liquid suspension of the support. (B.L.M.)

21794 ENVIRONMENTAL RADIATION SURVEILLANCE AT A NUCLEAR FUEL REPROCESSING PLANT. Davies, Sherwood (New York State Health Dept., Albany). Amer. J. Public Health, 58: 2251-60(Dec. 1968).

The increasing growth of nuclear power facilities and of fuel reprocessing plants and their radiation surveillance in Cattaraugus County in western New York state are surveyed and discussed. Details of findings on the first privately owned nuclear fuels reprocessing plants are presented and the fuel processing complex is described. An environmental survey in the area surrounding the processing plant during 1966 showed that gross β levels in Cattaraugus Creek reflected releases from the plant's lagoons. Gross β activity increased from a background of 10 pCi/l to a maximum of 1200 pCi/l. Air sampling for particulates showed accidental releases but would not detect low levels of release. Milk surveillance showed no increase from the plant operation. External radiation levels measured at 30 sites showed no significant differences in 1964, 1965, or 1966. The 1966 surveillance program results for air, water, and milk taken from the area that surrounds the nuclear fuels reprocessing plant were summarized, showing that the level of radioactivity downstream of the site was within the prescribed limits, as was the radioactivity in air and milk. In 1967 surveillance data showed that the gross β levels of radioactivity in the downstream sampling station generally declined from the levels that were reported in the latter part of 1966. (BBB)

21795 THE EXTRACTION OF URANIUM(VI) AND COBALT(II) FROM HYDROCHLORIC ACID SOLUTIONS BY CYCLOHEXYL- AND BENZYLALKYLAMINES. Sato, Taichi (Shizuoka Univ., Hamamatsu, Japan). Anal. Chim. Acta, 45: 71-80(Mar. 1969).

The partition of uranium(VI) and cobalt(II) between hydrochloric acid solutions and solutions of cyclohexyl- and benzylalkylamines in benzene was investigated at different conditions. The effects of amine structure and organic solvent on the extractions were also examined. It is found that cyclohexyl- and benzylalkyl tertiary amines are more efficient extractants for uranium and cobalt than secondary amines; a benzyl group is essential for promoting the extraction efficiency; the efficiency is reduced when the alkyl chain is branched and is strongly influenced by the kind of organic solvent used as diluent. (auth)

21796 EXTRACTION OF ZIRCONIUM INTO A LIQUID PHASE WITH n-BUTANOL. I. Dragulescu, C.; Simonescu, T.; Nemes, Gizella Rev. Roum. Chim., 13: 1469-76(Nov. 1968). (In German).

Optimal conditions for zirconium extraction from hydrochloric acid solutions with butanol under the action of trichloroacetic acid and sodium trichloraacetate were established. The method is applicable for extraction of zirconium from alloys and ores with deviations of less than 1%. (tr-auth)

21797 SEPARATION OF HYDROGEN ISOTOPES BY SORPTION ON SYNTHETIC ZEOLITES. Kochurikhin, V. E.; Zelvenskii, Ya. D. Zh. Fiz. Khim., 43: 206-10(Jan. 1969). (In Russian).

The coefficients of separation of the mixture H_2-D_2 on sorption by different synthetic zeolites were measured in the temperature range from 77 to 100°K at pressures from 60 to 200 mm Hg. It was found that experimental temperature relations, in the majority of cases, agree adequately with calculated values. From the temperature relation measured, the heats and entropies of the exchange reactions between gaseous deuterium and adsorbed hydrogen were determined. (tr-auth)

21798 COLLECTION OF URANIUM IN SEA WATER. II. ADSORBENTS FOR UPTAKE OF URANIUM IN SEA WATER. Ogata, Noboru (Japan Monopoly Corp., Odawara, Japan); Kakihana, Hidetake. Nippon Genshiryoku Gakkaishi, 11: 82-7(Feb. 1969). (In Japanese).

About fifty insoluble compounds of titanium, aluminum, magnesium, calcium, silicon, iron, manganese, zinc, chromium, lead, and tin were examined in a search for suitable adsorbents of uranium in seawater. The only materials that exhibited an effective uptake were titanium hydroxide, lead sulfide, and chromium hydroxide, the uptake capacities of which were 196, 134, and 68 μg/g, respectively. While their uptake capacity was small, manganese dioxide, zinc hydroxide, and lead hydroxide also adsorbed uranium in the pH range of seawater. Ferric hydroxide, ferrous sulfide, ferric phosphate, tin sulfide, titanium hydroxide, and manganese oxide were found to be good adsorbents in acidified seawater, though acidification of seawater would not be practical in industrial scale operations. Tannic acid salts of magnesium, calcium, and titanium adsorbed uranium in seawater, but had the drawback of relatively large solubility. (auth)

21799 SORPTION AND DIFFUSION OF RARE GASES IN HEULANDITE AND STILBITE. Barrer, R. M.; Vaughan, D. E. W. (Imperial Coll. of Science and Tech., London). Surface Sci., 14: 77-92(Mar. 1969).

With a view to establishing the potentiality of heulandite and stilbite as sorbents and encapsulating media for gases, the uptake of Ne, Ar, and Kr in these zeolites was studied at pressures up to 10,000 psi and at relatively high temperatures. Stilbite and heulandite were not stable to outgassing at high temperatures but with appropriate activation they sorbed rare gases copiously. For Ar and Kr as sorbates trapping was improved by allowing the crystals to be partially rehydrated when still charged with the rare gas. Diffusion coefficients, D, of the rare gases were determined in the crystals before and after partial rehydration. It was found that D was decreased and the energy of activation for diffusion of the larger rare gases was increased by rehydration. (auth)

21800 METHOD OF TREATING CARBON-CONTAINING MATERIAL. Ellison, Charles V.; Vondra, Benedict L. (to Nuclear Materials and Equipment Corp.). U. S. Patent 3,429,671. Feb. 25, 1969. Filed May 26, 1965.

A method of separating U from U-carbonaceous material consists of mixing the material with a sodium salt such as NaCl or Na_2CO_3 at a temperature of about 800° to 860°C to produce a fluffy yellow residue, Na_2UO_4, readily soluble in about 4$\underline{M}$ HNO_3. (Offic. Gaz.)

21801 SEPARATION OF RADIOACTIVE IODINE FROM AIR BY ACTIVATED CHARCOAL PAPER. Ullmann, W. (Staatliche Zentrale fuer Strahlenschutz der DDR, Berlin). Isotopenpraxis, 4: 459-61(Dec. 1968). (In German).

Studies on radioactive iodine content measurement in air using commercially activated charcoal paper 66/K (155 g/m^2) are reported. Applying this filter material enables a single-stage technique of detecting the total of radioactive iodine present in air and is preferable to aerosol filters prepared by silver nitrate. Some estimates are made with respect to the utilization of activated charcoal paper for cleaning waste air. (auth)

21802 THERMAL METHOD FOR DECLADDING STAINLESS STEEL OXIDE FUEL ELEMENTS. Novoselov, G. P.; Ageenkov, A. T. At. Energ. (USSR), 26: 230-4(Mar. 1969). (In Russian).

A study was made of surface phenomena and interactions in a system: uranium or plutonium dioxide–molten steels. At temperatures up to 1800°K, iron, Fe–Cr (to 30%) and Fe–Ni (to 50%) alloys, and stainless steels do not react very much with uranium or plutonium dioxide and do not wet them. With a temperature rise up to 2000°K the uranium transfer into the steel melt increases to 1%. Plutonium or uranium dioxide pellets 5 and 11 mm in diameter, respectively, are held on the surface of the molten steel. Fission product-simulating additives to UO_2 in amounts of 20% have no appreciable effect on the uranium transfer into the steel and the wetting of the fuel. Based on the data obtained a process was suggested and accomplished for thermal baring of fuel elements by melting steel components in inert atmosphere or in vacuum with the fuel being separated from the molten steel. The uranium content in the steel separated from the fuel does not exceed 0.05%. Uranium losses by entrainment with a sublimate and aerosols are below 0.006%. (auth)

21803 STUDY OF CAUSES OF INCOMPLETE URANIUM RECOVERY FROM GRANULAR FLUORIDE SLAG. Gusarov, M. S.; Nekrasova, N. P.; Oblomeev, E. N. At. Energ. (USSR), 26: 234-6(Mar. 1969). (In Russian).

Data are presented on the uranium form present in granular slag from the calcium thermal reduction of uranium tetrafluoride. The granulation is achieved by pouring molten slag into a water bath, thus producing cored granules. The uranium present in the granules is oxidized and a solid solution with calcium fluoride is formed with a maximum solubility of about 0.3 per cent. Therefore the uranium in the granular slag cannot be recovered with out destruction of the calcium fluoride crystal lattice. (auth)

21804 SUITABILITY OF H_2O–D_2O AS A TEST MIXTURE IN RECTIFYING COLUMNS. Lentz, H.; Wagner, H. Gg. (Univ., Bochum, Ger. Univ., Goettingen, Ger.). Ber. Bunsenges. Phys. Chem., 73: No. 1, 66-8(Mar. 1969). (In German).

The use of H_2O-D_2O as a test mixture for rectifying columns was investigated. A simple and rapid method for purification and analysis of the water samples is described. There is no loss of sample. Under normal conditions one can use the system H_2O-D_2O conveniently at 5 to 250 theoretical plates. (auth)

21805 SEPARATION OF RADIOACTIVE YTTRIUM FROM STRONTIUM BY MEANS OF MONO-OCTYL ANILINOBENZYLPHOSPHONATE. Herak, M. J.; Vujicic, N.; Jagodic, V. (Inst. Ruder Boskovic, Zagreb). Mikrochim. Acta, No. 1, 16-20(1969).

The separation of ^{90}Y from strontium by means of mono-octyl anilinobenzylphosphonate is described. Yttrium can be quantitatively extracted from 0.1 to 0.01$\underline{M}$ hydrochloric acid into the organic phase, while strontium remains in the aqueous layer. The separation can be carried out either from the diluted yttrium solution or when yttrium is present in the carrier-free form. The amount of strontium does not influence the extraction of yttrium. The separation factor is $>10^6$. The purity of the separated ^{90}Y was checked by means of its decay curve. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 21823, 21824, 22033, 22079, 22109–22112, 22284, and 22288.

21806 (NTS-79) GUIDEBOOK FOR FIELD TRIPS TO THE NEVADA TEST SITE. Christiansen, R. L.; Poole, F. G.; Barnes, Harley; Orkild, P. P.; Byers, F. M. Jr.; Carr, W. J.; McKeown, F. A.; Houser, F. N.; Shoemaker, E. M.; Emerick, W. L. (Geological Survey, Denver, Colo.). July 21, 1966. 57p. Dep. CFSTI.

Three topically oriented field trips are described. An examination of the thick miogeosynclinical section of Paleozoic rocks and some of the post-Paleozoic structural features were conducted on the first trip. The Timber Mountain caldera field trip is described. It is an assemblage of rocks of several thousand square miles in southern Nye County, Nevada. The last field trip guide features the observation of effects of explosions. Maps of all areas are included. (J.C.W.)

21807 (NYO-3086-8, pp VIII.1-28) INVESTIGATIONS OF THE PHYSICAL BEHAVIOR OF RADON DAUGHTERS IN CONFINED SPACES. Wrenn, McDonald E.; Van Pelt, Wesley; Rosen, Jerry (New York Univ., N. Y. Inst. of Environmental Medicine).

A brief description of an experimental system and method for obtaining analytical solutions to the diffusion equations for radon daughters is given. Also, a mathematical model for steady state solutions for the diffusion equations for radon-222 daughters in cylindrical geometry is presented. The results of this model are instructive for understanding the mechanisms of removal of radon daughters in uranium mines at the walls under dynamic conditions. (W.H.K.)

21808 (TID-24709) EVALUATION OF CORE DATA, PHYSICAL PROPERTIES, AND OIL YIELD, USBM/AEC COLORADO CORE HOLE NO. 3 (BRONCO BR-1). Interagency Report: Oil Shale-1. Ege, John R.; Carroll, R. D.; Way, R. J.; Magner, J. E. (Geological Survey, Denver, Colo.). Sept. 5, 1968. 26p. Dep. CFSTI.

USBM/AEC Colorado Core Hole No. 3 (Bronco BR-1) is located in Rio Blanco County, Colorado. The collar is at a ground elevation of 6,356 feet. The hole was core drilled between depths of 964 and 3,325 feet with a total depth of 3,797 feet. The hole was drilled to investigate geologic, geophysical and hydrological conditions at a possible in situ oil-shale retorting experiment site. The drill hole passed through 1,157 feet of alluvium and the Evacuation Creek Member of the Green River Formation, 1,603 feet of the Parachute Creek Member and penetrated into the Garden Gulch Member of the Green River Formation. In-hole density log/oil yield ratio interpretation indicates that two oil-shale zones exist which yield more than 20 gallons of shale oil per ton of rock; an upper zone lying between 1,271 to 1,750 feet in depth and a lower zone lying between 1,900 to 2,964 feet. Halite (sodium chloride salt) is found between 2,140 to 2,185 feet and nahcolite (sodium bicarbonate salt) between 2,195 to 2,700 feet. Nahcolite was present at one time above 2,195 feet but has been subsequently dissolved out by ground water. The core can be divided into six structural units based upon degree of fracturing. A highly fractured interval is found between 1,646 and 1,899 feet, which coincides with the dissolution or leached nahcolite zone. Physical property tests made on core samples between 1,356 and 3,253 feet give average values of 11,988 psi for uniaxial compressive strength, 1.38 × 10^6 psi for static Young's modulus and 11,809 fps for compressional velocity. (auth)

21809 (UCRL-50578) PRESSURE-VOLUME RELATIONSHIPS FOR TUFFS AND RHYOLITES FROM THE NEVADA TEST SITE. Stephens, D. R.; Louis, H.; Lilley, E. M. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 15, 1969. 38p. Dep. CFSTI.

The pressure-volume (PV) systematics of over thirty tuffs and rhyolites were examined to find a suitable method of estimating PV data for unknown rock. When these rocks were divided into three classes, the PV data were found to correlate reasonably well with the initial densities of the samples. The three classes are: dry, vitreous; dry, crystalline; and saturated. Twenty-five tables of loading and unloading PV data are presented for rock of varying initial density for the three classes. In using these tables to estimate the PV properties of a rock, only its initial density and the appropriate class to which the sample belongs need to be known. Physical significance of the correlation is discussed and the limitations of the techniques are described. The tables will be useful in estimating PV data in cases where calculations of a detonation must be made for a rock medium in the absence of experimental data for the rock. (auth)

21810 RADIOISOTOPES AND PROTACTINIUM AGE OF NEOVOLCANIC ROCKS OF THE CAUCASUS. Cherdyntsev, V. V.; Kuptsov, V. M.; Kuz'mina, E. A.; Zverev, V. L. (Geological Inst., Moscow). Geochem. Int. (Engl. Transl.), 5: No. 1, 56-64(1968).

Translated from Geokhimiya, No. 1, 77-85(1968).

Maximum ages of neovolcanic rocks can be determined from Io ^{234}U and Pa/^{235}U ratios; these are the true ages only if the initial Io and Pa content of the lavas was zero. U, Th, Pa, and uranium isotopic ratios were determined in more than 100 neovolcanic rocks. Holocene ages, geologically estimated, of some volcanoes were confirmed by this method. (auth)

21811 ISOTOPIC COMPOSITION OF HYDROGEN AS A CLUE TO THE ORIGIN OF GROUND WATERS AND PETROLEUM. Brezgunov, V. S.; Vlasova, L. S.; Soyfer, V. N. (All-Union Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). Geochem. Int. (Engl. Transl.), 5: No. 1, 65-78(1968).

Translated from Geokhimiya, No. 1, 86-98(1968).

Small variations of about 10% in the deuterium content of petroleums indicate a close similarity in the isotopic hydrogen content in all crude oil progenitors. The average deuterium content of crude oil is similar to that in organic substances. Oil fields are not enriched in deuterium by exchange with that in the oil. (auth)

21812 RADIOCARBON DATING BY THE SCINTILLATION METHOD. Arslanov, Kh. A.; Gromova, L. I.; Polevaya, N. I.; Rudnev, Yu. P. (All-Union Geological Inst., Leningrad). Geochem. Int. (Engl. Transl.), 5: No. 1, 148-57(1968).

Translated from Geokhimiya, No. 2, 198-206(1968).

A method for the chemical preparation of samples submitted for ^{14}C dating is described. Age determinations of 32 samples including wood, rocks, and sediments (ranging from 300 to >62,000 years) are reported. Most of the age determinations are compared with palynological results. (auth)

21813 THORIUM ISOTOPES (^{230}Th, ^{232}Th) IN THE SURFACE LAYER OF THE INDIAN OCEAN SEDIMENTS. Kuznetsov, Yu. V.; Simonyak, Z. N.; Lisitsyn, A. P.; Frenklikh, M. S. Geochem. Int. (Engl. Transl.), 5: No. 1, 169-77(1968).

Translated from Geokhimiya, No. 2, 218-27(1968).

It has been demonstrated that the content of ionium (^{230}Th) in the surface layer of oceanic sediments depends on the depth of water, effective surface area of the sedimentary particles, and on the rate of sedimentation. ^{230}Th is co-precipitated with the hydroxides and phosphates of Fe and Mn, while ^{232}Th is contained in the sedimentary detrital particles. (auth)

21814 THE SELECTIVITY COEFFICIENT OF SLOWLY EXCHANGEABLE CALCIUM AND STRONTIUM. Taylor, A. W. (Agricultural Research Service, Beltsville, Md.). Soil Sci., 107: 58-62(Jan. 1969).

The slow approach to isotopic equilibrium shown by the exchangeable strontium in some acid soils of the North Carolina Coastal Plain and also exhibited by the exchangeable calcium is discussed. In these soils the exchange equilibrium between these ions may not be reached in less than one month. At equivalent fractions of calcium from 1.0 to 0.9 the slow exchange reaction does not show any significant selectivity for either ion, although the calcium may approach isotopic equilibrium a little more rapidly than the strontium. The slow exchange has no practical significance for the separation of calcium and strontium in field conditions, but has important implications for the interpretation of data from laboratory or pot experiments with soils in which it occurs. (auth)

21815 TRITIUM GEOPHYSICS AS AN INTERNATIONAL RESEARCH PROJECT. Suess, Hans E. (Univ. of California, San Diego, La Jolla). Science, 163: 1405-10(Mar. 28, 1969).

The presence of artificial tritium on the surface of the earth provides an opportunity for the study of a number of problems in environmental sciences. The environmental tritium can be used as a tracer for water vapor in the atmosphere, precipitation, runoff, and groundwater on land, and for the various water masses of the oceans. The need for a worldwide and long-range program is discussed. The extent of the program in time and space, as well as its multidisciplinary nature, indicates the necessity for broad-based international and interinstitutional cooperation. Such a program is now in progress at the International Atomic Energy Agency in cooperation with national and university laboratories of several countries. The program makes use of a sampling network for precipitation. In addition to providing data as a basis for future studies, the work in progress is yielding immediate results in the field of hydrology of arid regions and in regard to problems of water supply and water contamination in developing countries. (auth)

21816 LOW-LEVEL TRITIUM MEASUREMENTS FOR HYDROLOGICAL APPLICATIONS. Otlet, R. L. (United Kingdom Atomic Energy Authority, Wantage, Eng.). pp 10-17 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

Tritium measurements can make a significant contribution to many standard geological investigations on groundwater origins, movement and potentialities. A laboratory has been set up at W.R.L. for tritium measurements in samples of natural water. The principles and techniques currently used at W.R.L. for these measurements are described. (auth) (UK)

21817 EQUILIBRIUM STUDIES ON THE ADSORPTION OF CESIUM BY CLAY MINERALS. Cheng, H. S.; Leu, A. D. (National Tsing Hua Univ., Hsinchu, Taiwan). Ho Tsu K'o Hsueh, 6: 83-9(Oct. 1968).

Adsorption of cesium by terrigenous clay materials was studied. The K_d values were proportional to the R_K values of the montmorillonites regardless of their origin. The equilibrium studies were made for Cs–Na, –K, –Mg, and –Ca systems. Apparent application of the mass action law for Cs–K and Cs–Mg systems were found. For the other systems, the doubly saturated samples showed little difference from the singly saturated ones. The application of the mass action law to the systems containing tracer quantity of cesium ion in the presence of macroquantity of sodium, potassium, magnesium, or calcium ions, involving the terrigenous clay materials was investigated. The results revealed that the mass action law held, like in the case of the marine sediments, only for the Cs–K and Cs–Mg exchange systems. (auth)

21818 QUANTITATIVE AND RADIOACTIVE SULFUR (^{35}S) LIQUID SCINTILLATION COUNTING METHOD FOR DETERMINING SOIL AND PLANT SULFUR. Blair, Graeme J.; Crofts, F. C. (Univ. of Sydney). Soil Sci., 107: 277-80(Apr. 1969).

A method for counting ^{35}S, present either as sulfate or total S in soil and plant materials, is presented. The ^{35}S counting can be carried out with an efficiency of greater than 90% and the same extract used for a colorimetric determination of sulfur present. The procedure involves the reduction of the plant or soil sulfur to hydrogen sulfide and absorption in sodium hydroxide, an aliquot of which is mixed with a dioxane based scintillation phosphor and counted in a liquid scintillation counter. Color development for quantitative analysis is by a bismuth nitrate-acetic acid-gelatin procedure. (auth)

21819 COMPUTER PROGRAM FOR CONVERTING NEUTRON PROBE READINGS TO SOIL WATER EQUIVALENTS. Popham, T. W.; Ursic, S. J. (Forest Service, New Orleans). Soil Sci., 107: 302(Apr. 1969).

A program written in FORTRAN IV was developed for IBM-7044 or IBM-7094 for converting neutron probe readings to soil water equivalents. On the IBM-7044, an on line card reader, card punch, and printer are employed, the IBM-7094 uses BCD tapes for input and output. (F.S.)

Meteorology

Refer also to abstracts 21838, 22283, 22284, and 23942.

21820 (AERE-Trans-1106) INVESTIGATION OF THE ATTACHMENT OF NEUTRAL AND ELECTRICALLY CHARGED EMANATION DECAY PRODUCTS TO AEROSOLS. MEASUREMENT OF THE AEROSOL SIZE SPECTRUM AND OF THE ATTACHMENT COEFFICIENT OF NEUTRAL DECAY PRODUCTS. Mohnen, Volker (Munich Univ. (West Germany)). Translated by W. G. Stripp for Atomic Energy Research Establishment, Harwell, Eng., from reports BMwF-FBK-66-11; BMwF-FBK-67-78. 72p. Dep. CFSTI. UK 10s.

Thesis.

Abstracts of this paper, prepared from the original language, appeared as NSA 20: 43167 and 22: 4226. (R.C.K.)

21821 (CONF-690406-2) METEOROLOGICAL REQUIREMENTS AND OPERATIONAL FALLOUT PREDICTION TECHNIQUES FOR PLOWSHARE NUCLEAR DETONATIONS. Mueller, Harold F. (Environmental Science Services Administration, Las Vegas, Nev. Air Resources Lab.). [1968]. 30p. Dep. CFSTI.

From Symposium on Public Health Aspects of Peaceful Uses of Nuclear Explosives, Las Vegas, Nev.

Meteorological support requirements for Plowshare nuclear detonations are shown to depend on a number of factors. The importance of adequate support to the effective planning and safe conduct of a nuclear detonation is described. An example of the influence of atmospheric conditions on radioactive cloud development and local transport and fallout of radioactive debris is presented. Prediction of the future state of atmospheric wind structure, required for fallout predictions, depends on an adequate definition of its initial state and its rate of change. This definition, in turn, is shown to depend on an upper wind sounding network of appropriate station density. An operational technique currently used for nuclear cratering fallout predictions is described and shown to produce results of useful accuracy. (auth)

21822 (FFR-403/68) MEASUREMENTS OF FISSION PRODUCT ACTIVITY IN AIR AND IN PRECIPITATION UP TO 30 JUNE 1968. Report No. 29. (Forsvarets Forskningsrad, Copenhagen (Denmark)). Oct. 1968. 10p. Dep.

Fallout measurement results on dust and precipitation samples from Copenhagen, Jutland, the Faroe Islands, and Greenland are reported. Monthly mean values of total beta-activity in air at ground level are listed and specific activity of each sample recorded. When possible the cesium-137 contents in the monthly samples were measured and the results listed. The concentration of strontium-90 in the monthly dust samples from Copenhagen is given. By gamma-spectrometric measurements on dust samples from a high-volume air sampler in Copenhagen, the activity in pCi/1000 m^3 of zirconium-95–niobium-95 and cesium-137 were measured and are delineated for each sample. Data from radiochemical determination of ^{137}Cs and ^{90}Sr in monthly precipitation samples from Copenhagen and Thorshavn are tabulated. Results from Greenlandic precipitation samples will be given later. (Denmark)

21823 (MLM-1619) ENVIRONMENTAL MONITORING REPORT: JULY-DECEMBER 1968 AND 1968 SUMMARY. Anderson, H. F.; Sheehan, W. E. (Mound Lab., Miamisburg, Ohio). Mar. 21, 1969. Contract AT(33-1)-Gen-53. 50p. Dep. CFSTI.

The concentration of radioactive materials detected in the environment surrounding Mound Laboratory, Miamisburg, Ohio, is presented for the second half of 1968, and a summary is presented for the entire year. The average concentration of radionuclides from Mound Laboratory in the Great Miami River (averaged over one year) and in the environmental air was within the stringent standards of safety specified by the Atomic Energy Commission. (auth)

21824 (NIRS-19) RADIOACTIVITY SURVEY DATA IN JAPAN. (National Inst. of Radiological Sciences, Chiba (Japan)). May 1968. 18p. Dep.

Strontium-90 and cesium-137 contents in rain and dry fallout from April 1967 to March 1968 are tabulated. Sampling results for strontium-90, cesium-137, and cerium-144 in airborne dust from April 1967 to March 1968 are given. Monthly external doses from fallout and exposure due to natural radiation are listed. Also, the annual variation of carbon-14 concentration in ethanol from stocks dating from 1949 to 1967 are presented, and strontium-90 and cesium-137 contents in ground waters from April 1967 to March 1968 are listed. (W.H.K.)

21825 EFFECT OF CLOUD ON THE RADIOACTIVE CONTAMINATION IN THE BIOSPHERE. Marquardt, W. Z. Meteorol., 20: Nos. 1-6, 37-42(1968). (In German).

Measurements made between 1960 and 1964 at high altitude observation stations showed that clouds can increase atmospheric radioactivity up to threefold, while the moisture in the clouds is up to fifteen times as radioactive as rainwater falling in the area at the same time. This phenomenon was attributed to the ability of the small cloud droplets to absorb relatively large amounts of contaminant. These droplets usually form condensation nuclei; the raindrops formed over them partially decontaminate the atmosphere. The effect is particularly pronounced at the formation stage of the cloud cover; as time passes, the effect decreases logarithmically. Winds complicate the processes, with the decontaminating effect increasing as the wind velocity increases. In flat areas, where simultaneous wind and cloud is rare, this effect is relatively unimportant. (JPRS)

21826 RADIOACTIVE FALLOUT IN PRAGUE DURING THE YEAR 1967. Spurny, Kvetoslav; Machala, Oldrich (Inst. of Physical Chemistry, Prague). Zdrav. Tech. Vzduchotech., 11: 237-40(Dec. 1968). (In Czech).

Records of the radioactive fallout for the year 1967 are reviewed. The influence of the Chinese atomic explosions on the fallout figures at Prague in 1967 was very slight. Fallout figures for 1961 when the atomic explosions were released by the USA. USSR, and France are reviewed. (JPRS)

21827 PROGNOZIROVANIE RADIOAKTIVNOGO ZARAZHENIYA. (Radioactive Fallout Prediction). Timofeev, V. N.;

Nesytov, Yu. K. Moscow, Voennoe Izdatel'stvo Ministerstva Oborony SSSR, 1969. 102p.

A brief review is given of radioactive contamination as a factor in nuclear explosions, radioactive fallout products, formation of radioactive clouds and characteristics of regions of radioactive fallout. Data on fallout prediction and prediction analysis are discussed. The methods of prediction and estimation of radioactive conditions are described. (R.V.J.)

21828 VARIATIONS OF THE ^{89}Sr/^{90}Sr RATIO IN RAIN CAUSED BY THE CHINESE NUCLEAR EXPLOSIONS OF DECEMBER 28, 1966, AND JUNE 17, 1967. Swindle, D. L.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 74: 2136-40(Apr. 15, 1969).

Strontium-89/-90 ratios in samples of rain and snow were measured at Fayetteville, Ark., from Jan. through Sept. 1967. Variations are explained as being due to the two Chinese nuclear explosions of Dec. 28, 1966 and June 17, 1967. A reported Russian underground explosion of Dec. 18, 1966 was not observed. (F.S.)

Mineralogy and Exploration

21829 (BNL-13252) VALUE AND PROSPECTS OF RECOVERY OF URANIUM FROM U. S. COAL DEPOSITS. Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Jan. 1969. 45p. (CONF-690502-2). Dep. CFSTI.

From 65th National Meeting of the American Institute of Chemical Engineers, Cleveland, Ohio.

Based on the electrical generating capacity requirements in the United States up through the year 2000, it is ascertained that the fuel economy of the foreseeable future will depend mainly on coal and uranium reserves. It is concluded that the nuclear power industry needs to uncover additional reserves of low cost uranium fuels while pursuing the development of an economically competitive nuclear breeder reactor, and that western coal deposits need to be developed to meet the increasing electrical power demand. It is recommended that a thorough survey of the coal and uranium geology in the western fuels be made and a development effort be initiated for the demonstration of low cost long distance cryogenic transmission lines as well as new coal-based power cycle systems such as large scale gasification and MHD electrical power generation processes. (auth)

21830 (RT/GEO-(68)18) THE REGIONAL SURVEY BY GEOCHEMICAL PROSPECTING OF THE TRENTINO-ALTO ADIGE AREA. Dall'aglio, M.; Mittempergher, M.; Tedesco, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 21p. (In Italian). (CONF-660967-1). Dep.

From International Symposium on Mineral Deposits in the Alps, Trento-Mendola, Italy.

Geochemical prospecting allows a direct evaluation of ore occurrence and defines feasible areas by graduated stages of approximation. A prospection on a regional basis was carried out in the Northern part of the Tretino Alto Adige to identify the hydro geochemical halos of uranium, fluorine, and heavy metals (Cu, Pb, Zn). The results of the prospection are presented and the utility, the economics, and speed of the geochemical method in the ore researches projected. The study has confirmed that the hydrogeochemical dispersion halos of the elements exist and they can be singularly followed applying a large sampling grid. The halos correlate with the different geological and minerogenetical conditions. A 4.600 km^2 area has been prospected and the conclusions have been drawn by the study of 268 alluvium and water samples. (tr-auth)

21831 CONTENT OF RARE EARTH ELEMENTS IN ACCESSORY MINERALS. Mineev, D. A. (Inst. of Mineralogy, Geochemistry and Crystal Chemistry of Rare Elements, Moscow). Geochem. Int. (Engl. Transl.), 5: No. 1, 187-9(1968).

Translated from Geokhimiya, No. 2, 237-9(1968).

A summary of published analytical data (based on 1000 analyses) on the rare earth content in 17 common rare-earth bearing minerals is presented. (auth)

21832 UNSTABLE SULFUR COMPOUNDS AND THE ORIGIN OF ROLL-TYPE URANIUM DEPOSITS. Granger, H. C.; Warren, C. G. (Geological Survey, Denver. Geological Survey, Fort Collins, Colo.). Econ. Geol., 64: 160-71(Mar.-Apr. 1969).

Roll-type uranium deposits are formed by a supergene process that depends on limited oxidation of early formed pyrite in the host rock. Among the initial products of oxidation is a series of unstable soluble sulfur species, principally sulfite, which slowly decompose and ultimately form sulfate and sulfides. Because sulfate is kinetically inert to low-temperature nonbiologic oxidation-reduction reactions, and because the unstable sulfur species and hydrogen sulfide are strong and active reducing agents, the net result of limited oxidation is to produce a strongly reducing environment. Either some of the intermediate sulfur products or hydrogen sulfide may recombine with ferrous iron under these conditions to form the iron sulfide minerals associated with the ores. Laboratory experiments and chemical theory suggest that the entire sequence of reactions can be carried out in a biologically sterile environment and that the sulfur isotopic composition of the reconstituted pyrite might be indistinguishable from pyrite formed by biogenic processes. These unstable intermediate sulfur species may also be involved in the formation of other supergene-enriched sulfide ores as well as in the transportation and deposition of elements such as barium and selenium. (auth)

Oceanography

Refer also to abstracts 21815 and 21888.

21833 OCEANOGRAPHIC STUDIES BY MEANS OF NATURAL AND ARTIFICIAL RADIOACTIVE ISOTOPES AND STABLE ISOTOPES. Miyake, Yasuo (Tokyo Kyoiku Univ.). Nippon Kaiyo Gakkaishi, 23: 148-55(June 1967). (In Japanese).

Some aspects of the distribution and chemical nature of radioactive substances which have been investigated extensively in the field of oceanography are discussed. The Ra and U concentrations in the ocean are not equally distributed. Surprisingly, the ratio of ^{234}U/^{238}U is larger than 1 in the ocean, possibly as a result of the ^{234}U from leaching of rocks and run off into the ocean. The effect of living organisms on the distribution and life cycle of radioelements in the ocean has also been studied. The U content is most affected by living organisms in the ocean and the Ra has the least effect. Results of radioactive contamination of the oceans as the result of nuclear tests, investigated since 1954 are considered. Vertical distribution of ^{137}Cs and ^{90}Sr in the Western North Pacific has developed rapidly. Similar observations of rapid diffusion of artificial radioactive isotopes by Soviet oceanographers in the Black Sea are also mentioned. (BBB)

Seismology

Refer also to abstracts 21842 and 22114.

21834 LONGITUDINAL WAVES FROM THE NOVAYA ZEMLYA NUCLEAR EXPLOSION OF OCTOBER 27, 1966, RECORDED AT THE WARRAMUNGA SEISMIC ARRAY. Wright, C.; Muirhead, K. J. (Australian National Univ., Canberra). J. Geophys. Res., 74: 2034-4(Apr. 15, 1969).

The apparent velocity and azimuth of P waves from the Novaya Zemlya nuclear explosion of October 27, 1966, were measured for the Warramunga array and were used to work out possible crustal structures for correcting measured apparent velocities and azimuths in the azimuth ranges 335° to 355°. Comparison of the measured apparent velocities and azimuths for seven earthquakes at different distances, but at similar azimuths to Novaya Zemlya, has shown that the computed structures give satisfactory corrections. Measurements of apparent velocity and azimuth have been used as an aid in identifying the phases PKIKP, PP, PcPPcP, PKKP, PcPPKP, and PKPPKP in the explosion record; similar measurements have been made for coherent signals not corresponding to any of the conventional phases. (auth)

21835 X-RAY DIFFRACTION ANALYSIS OF PLASTIC DEFORMATION IN THE SALMON EVENT. Braun, R. L. (Univ. of California, Livermore); Kahn, J. S.; Weissmann, S. J. Geophys. Res., 74: 2103-17(Apr. 15, 1969).

X-ray diffraction rocking curve studies were combined with x-ray topography of halite crystals taken from the Tatum salt dome before and after the 5-kT Salmon nuclear explosion. The results of these measurements indicated that beyond a radial distance of 126 meters from the shot point the halite had experienced no detectable shock-induced plastic deformation. At distances less than 126 meters the strain accommodation consisted of intragranular gliding on multiple slip systems and localized rotation of substructural lattice regions with respect to each other. This turbulent plastic deformation led to pronounced lattice kinking and eventually to a general fragmentation of the halite crystals. The breakup of the halite lattice into small subgrain blocks and the misorientation between subgrain blocks increased with approach toward the shot point. Because of the relatively low values of the angular range of reflection of the subgrain blocks in comparison with the large induced misorientation between the blocks, it was inferred that excessive accumulation of long-range stresses was absent and that the shocked structure tended to assume a configuration of low lattice strain. (auth)

21836 SHOCK SPECTRA FROM SUBSURFACE NUCLEAR EXPLOSIONS. Galbraith, Frank W.; Schreiner, Robert N. (TRW Systems, Redondo Beach, Calif.). J. Eng. Mech. Div., Amer. Soc. Civil Eng., 94: 1015-27(Oct. 1968).

The investigation was limited to reed-gage data obtained from completely contained underground explosions. Correlation equations were developed from which the displacement-shock spectrum of underground nuclear explosions can be calculated with acceptable accuracy. The geologic parameters, limited by available data, were generally those associated with the shot point rather than the gage locations. They included seismic velocity, mass density, reed displacement, reed frequency, yield, and slant range. Correlation equations for vertical displacement and horizontal displacement were found with restrictions that the explosion be completely contained and that the frequency be greater than 2 cps. The displacement shock spectrum is related to the pseudo-velocity shock spectrum and to the acceleration shock spectrum by $A = \omega V = \omega^2 d$ in which A = acceleration shock spectrum; V = pseudo-velocity shock spectrum; d = displacement shock spectrum; and ω = circular natural frequency. The shock spectra are useful in design and analysis of structures subject to ground shock from underground nuclear explosions. The equations were used to compute spectra for several more recent nuclear explosions. Over 90% of the vertical and almost 75% of the horizontal-radial predictions were within a factor of two of the measured values. This is considered excellent correlation for ground shock prediction, usually an inexact process. (BBB)

21837 EARTHQUAKE ENGINEERING FOR NUCLEAR POWER PLANTS. Sharpe, Roland L. (John A. Blume and Associates, San Francisco). Civil Eng. (N. Y.), 39: 39-43(Mar. 1969).

The potential damage exposure from an accident at a large nuclear reactor makes it imperative that earthquake motions be considered even in areas that now appear to have low seismic activity. Procedures utilized by one firm in the design and analysis of nuclear power plants for resistance to earthquake forces are described. The analyses have included determination of the earthquake exposure of nuclear plant sites, development of seismic design criteria, and the dynamic analysis of buildings, structures, equipment, piping, and soil-structure systems. Capability was developed in these 3 areas because of the close inter-relation of earthquake motion, site characteristics, soil-structure interaction, and structure response. After the earthquake exposure for the site is postulated, the effects of the probable earthquakes at the site are evaluated. Detailed site geology investigations are made to determine the geologic structure and geotechnical properties of the site. Seismic velocities (both compressional and shear wave) of the different layers of material are determined for computing dynamic elastic moduli and other dynamic properties. The site characteristics are used to develop predicted probable frequencies of earthquake motions. Dynamic analysis is performed by developing a mathematical model which is representative of the actual structure and/or items of equipment, all coupled with the foundation materials. The results of the dynamic analysis are presented as plots or tabulations of accelerations, displacements, moments, and shears at various elevations in the structure for both translation and torsional rotation. The stresses in members due to the seismic loads can then be calculated by normal methods of structural analysis. Computer program output for piping systems also includes stresses in each pipe at selected points. (BBB)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 21806, 21808, 21809, 21821, 21836, and 22040.

21838 (CONF-690312-1) VENTING AND FALLOUT PREDICTION. Allen, Philip W. (Environmental Science Services Administration, Las Vegas, Nev. Air Resources Lab.). Mar. 31, 1969. 19p. Dep. CFSTI.

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz.

Methods for the evaluation of the potential for the accidental release of radioactive material following an underground nuclear explosion are discussed. Industrial applications of nuclear explosives have the same requirements for radiological safety as those of the Atomic Energy Commission, even in the presence of perhaps greater pressure for economy. To maintain radiological safety, it is essential that all radioactive explosion products be contained underground whenever possible. When it is impossible to avoid some release of radioactivity to the atmosphere, the amounts released must be minimized and adequate precautions be taken to protect people from significant exposures. These basic requirements call for an understanding of the containment phenomena in order to assure, for only a reasonable cost, that leakage will not occur or will be a minimum. It calls for an evaluation before each detonation of the probability of accidental release of radioactivity, and the maximum exposure levels that might result. Predictions are required of the path that a vented cloud would follow and of the time it would take to reach people or activities. Based on these predictions, an effective plan is required for the protection or evacuation of the public and documentation of any human exposure. An active research program is required to assure that detonation safety is maintained at a satisfactorily effective level and is adapted to each new industrial application or explosive device. (auth)

21839 (LA-3757) THE 1965 ARPA-AEC JOINT LIGHTNING STUDY AT LOS ALAMOS. VOLUME IV. DISCRIMINATION AGAINST FALSE TRIGGERING OF AIR-FLUORESCENCE DETECTION SYSTEMS BY LIGHTNING. Barasch, Guy E. (Los Alamos Scientific Lab., N. Mex.). July 26, 1968. Contract W-7405-eng-36. 26p. Dep. CFSTI.

Optical discrimination techniques to prevent false triggering of nuclear-explosion-excited air-fluorescence detection systems by lightning are evaluated. The spectra of lightning and of air fluorescence are very different: lightning emits a strong continum and neutral and ionized atomic line radiations, whereas the air-fluorescence spectrum is primarily molecular band radiation. The discrimination technique makes optimum use of two detectors to identify the source of a light pulse through these differences. False triggering of the detection system occurs either when the source is misidentified or when one of the measurements cannot be made because the incident signal at that wave length is below the detection threshold. A statistical prediction of false-triggering rates taking into account: lighting emissions, air-fluorescence emissions, atmospheric propagation mechanisms, detector-component parameters, and background radiation is given. Two detection-system designs are evaluated, each of which specifies a narrow passband at 3914 Å for detection of N_2^+ 1N (0,0) fluorescence. One uses 2-in.-diam "LASL-2" all-sky radiometers; the other uses improved 5-in.-diam "LASL-5" all-sky radiometers. Four discrimination-channel wavelengths are evaluated: 4140 Å (40-Å bandwidth), 4950 Å (220-Å bandwidth), 5000 Å (20-Å bandwidth), and 6563 Å (20-Å bandwidth). The predicted yearly false-triggering rates at a typical site are:

	Discrimination Wavelength			
	4140 Å	4950 Å	5000 Å	6563 Å
Two-inch radiometers	1180	~6	<420	710
Five-inch radiometers	660	0.2	<136	510

The best discrimination capability is realized with the 4950-Å, 220-Å-bandwidth channel, because the 3914-Å/4950-Å radiated spectral-intensity ratios of lightning and air fluorescence are substantially different, and because lightning radiates more flux in the 220-Å band near 4950 Å than in any of the other bands considered. The rates of source misidentifications and below-threshold false triggers are therefore minimized. Owing to the superior discrimination characteristics of the 4950-Å channel in conjunction with 5-in. radiometers, we recommend this combination for improvement of current detection systems or use in any new system designs. (auth)

21840 (ORNL-TM-2502) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, October 1–December 31, 1968. Arnold, W. D.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). Feb. 12, 1969. 16p. Dep. CFSTI.

Uranium was weakly adsorbed from synthetic copper ore leach liquors on Safford copper ore tailings. A small amount of the uranium deposited on the sheet iron used to precipitate copper from the liquor, but it did not contaminate the cement copper product. Almost 92% of the tritium was removed from contaminated oil shale by treating it for 15 days at 200°C with moist air. About 70% of the tritium was removed from the shale in the first day. Tritium penetrated to the center of a 28 mm shale cube in 25 days of exposure at 85°C to tritiated water vapor. When contaminated shale was retorted, the tritium concentration was approximately constant in the oil fractions collected throughout the run. (auth)

21841 (PNE-G-30) NON-GASEOUS RADIOISOTOPES. PROJECT GASBUGGY CHIMNEY GAS. Smith, Charles F. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 15, 1969. 12p. Dep. CFSTI.

Attempts to determine nongaseous radioisotopes in samples from the Project Gasbuggy site are described. The maximum concentrations possible were calculated. The limits established were low enough that the possible presence of these "semi-volatile" nuclides can be ignored in the case of Gasbuggy. (M.C.G.)

21842 (PNE-G-32) SEISMIC ANALYSIS OF A NUCLEAR EXPLOSION, GASBUGGY. Reagor, B. G.; Gordon, D. W.; Jordan, J. N. (Coast and Geodetic Survey, Rockville, Md.). Dec. 10, 1967. 73p. Dep. CFSTI.

A comparative study between Gasbuggy and Gnome data was made which shows considerable differences in observed travel times, amplitudes, and in the excitation of surface waves. The Pn and P arrivals from Gasbuggy follow the Jeffreys–Bullen curve closely, whereas the arrival times for Gnome were early to the east and late to the west. Relatively higher amplitudes of phases associated with Pg and Lg were recorded to the east of Gasbuggy, whereas Pn and P and surface waves (LR) recorded higher amplitudes to the west of Gasbuggy. Rayleigh waves were strongly recorded at large distances from Gasbuggy with an average magnitude of 4.09, as compared with an M_B and M_E of 5.21 and 4.73, respectively. Since P and PKP data were not recorded beyond 86 degrees, the body wave magnitude computed according to Evernden (M_E) appeared to be a more reasonable value. A refinement of the Gasbuggy location was attempted by adjusting the arrival times relative to the residuals observed from Gnome. The maximum epicentral error increased approximately 7 kilometers to the north and 22 kilometers to the west. (auth)

21843 (SC-DC-69-1716) NUCLEAR EXCAVATION. Vortman, L. J. (Sandia Labs., Albuquerque, N. Mex.). Mar. 1969. 21p. (CONF-690312-2). Dep. CFSTI.

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz.

The projects suggested for possible nuclear excavations during the past 12 to 15 years are listed and briefly described. Progress in each is reviewed, and the information needs of nuclear excavations are examined. No usable nuclear excavation has been accomplished, but understanding of explosive excavation techniques has increased enormously. (L.C.L.)

21844 (SC-M-69-33) OPERATION PRAIRIE FLAT, AIRBLAST PROJECT LN-106, MICROBAROGRAPH MEASUREMENTS, FINAL REPORT: "DISTRIBUTION OF AIRBLAST AMPLITUDES IN THE OZONOSPHERE SOUND RINGS". Reed, Jack W. (Sandia Labs., Albuquerque, N. Mex.). Feb. 1969. 49p. Dep. CFSTI.

Eighteen microbarographs recorded airblast from PRAIRIE FLAT and three 1.2-ton HE blasts. Sensors were spaced at 1- and 2-mile intervals at distances from 119 to 141 miles west of the bursts, to record ozonosphere ducted propagations, hopefully in a caustic. Results showed that there were humps in the amplitude-versus-distance curve which were observed to pass through the array and changed from shot to shot. These appear to be the caustic, which was broken up by atmospheric irregularities, and resulted in approximately double amplitudes over 6- to 8-mile bands. Amplitudes were proportional to the 0.425 power of apparent blast yield, which was close to the 0.40 value previously measured. (auth)

21845 (TID-24996) SUMMARY REPORT ON ACTIVITIES FOR ASSURING THE SAFETY OF UNDERGROUND NUCLEAR TESTING. (Nevada Operations Office (AEC), Las Vegas). Apr. 1969. 23p. Dep. CFSTI.

The effects of underground nuclear explosions are described. Safety procedures and the interworkings of the agencies concerned are explored. Ground water conditions were examined and sites selected to avoid unfavorable permeation. Characteristics of ground motion caused directly by underground nuclear explosions can be predicted with confidence. Aftershocks are limited usually to the vicinity of the burst point. The causes of tsunamis and other water waves are discussed. The proposed Amchitka tests and the calculated risks are discussed. It was concluded that safety begins during the design of a nuclear device. (J.C.W.)

21846 (UCRL-71434) RADIOACTIVITY SOURCE TERMS FOR UNDERGROUND ENGINEERING APPLICATION. Tewes, Howard A. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 24, 1969. 16p. (CONF-690406-4). Dep. CFSTI.

From Symposium on Public Health Aspects of Peaceful Uses of Nuclear Explosives, Las Vegas, Nev.

The total "source term" (radioisotope production) resulting from the detonation of an underground nuclear explosive must be determined by considering possible sources of radioisotopes. These sources include fission products, neutron activation products from the explosive package, and neutron activation products formed at relatively large distances from neutron source consisting primarily of the radioisotopes produced by neutron capture. The radioisotopes actually produced in the Gasbuggy Project and in ore crushing in the Sloop project are compared with calculated radioisotope production. (F.S.)

21847 (UCRL-71439) TECHNICAL PROBLEMS AND FUTURE UNDERGROUND ENGINEERING EXPERIMENTS. Higgins, Gary H. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 26, 1969. 25p. (CONF-690406-5). Dep. CFSTI.

From Symposium on Public Health Aspects of Peaceful Uses of Nuclear Explosives, Las Vegas, Nev.

The technical problems to be solved in future underground engineering experiments are of two kinds: determination of the effects of the physical and chemical properties of the explosion site on the nuclear explosion; and engineering of the explosive detonation system to provide adequate safety and security, concurrently with minimum total costs per explosion. The semi-empirical equations for explosion effects can be trusted only in the range of explosive energy, depth of burst, and rock type for which there is prior experience. Effects calculations based on the principles of continuum mechanics and measurable geophysical properties appear to work in the few test cases, such as Gasbuggy, to which they have been applied. These calculational methods must be tested in a variety of situations. The relevance of dynamic and static measurements on Dragon Trail, Bronco, Rulison, Sloop, Ketch, and Pinedale to proving the methods is discussed. (auth)

21848 (UCRL-71491) TECHNICAL PROBLEMS AND FUTURE CRATERING EXPERIMENTS. Knox, Joseph B. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 19, 1969. 34p. (CONF-690406-1). Dep. CFSTI.

From Symposium on Public Health Aspects of Peaceful Uses of Nuclear Explosives, Las Vegas, Nev.

Some of the key technical problems that remain to be solved in nuclear cratering technology are reviewed. These include: developing a broader understanding of the effects that material properties and water content of the earth materials around the shot have on cratering behavior, extending the experimental investigation of retarc formation to include intermediate yields and various materials, and improving our ability to predict the escape of radioactive material to the atmosphere to form the cloud source responsible for fallout. The formation processes of ejecta craters, retarcs, and subsidence craters are described in the light of our present understanding, and the major gaps in our understanding are indicated. Methods of calculating crater and retarc formation are discussed, with particular reference to the input information needed. Methods for calculating fallout are presented, and their shortcomings are discussed. A preliminary analysis of the safety factors associated with the presently proposed nuclear excavation concepts is presented. (auth)

21849 RADIONUCLIDE PRODUCTION FOR THE NUCLEAR EXCAVATION OF AN ISTHMIAN CANAL. Vogt, James R. (Univ. of Missouri, Columbia). Bioscience, 19: 138-9(Feb. 1969).

The extent of radionuclide release to the environment in the use of nuclear explosions for excavation of the proposed Isthmian Canal was estimated. Characteristics of nuclear explosives for construction of a sealevel canal are given. In addition to fission products, various radionuclides would be produced by a thermonuclear explosion. These would include residual fissionable or fusionable materials not consumed prior to the disassembly phase of the detonation; thermonuclear reaction products such as tritium and ^{7}Be, induced activities from the reactions of neutrons from the fission and fusion processes with device materials, ^{54}Mn, ^{55}Mn, ^{55}Fe, ^{59}Fe, ^{185}W, ^{187}W, and ^{203}Pb; and induced activities from the reactions of neutrons escaping from the device canister with the grout and rock surrounding the device, such as from ^{24}Na, ^{32}P, ^{45}Ca, ^{56}Mn, ^{55}Fe, and ^{59}Fe. While decreasing the fission-to-fusion ratio would lower the amount of fission products produced by a given device, it also would tend to increase the total neutron yield. For most of the radionuclides released during a cratering detonation most activity would be distributed in the fallback and throwout material. Of the vented material, most would be deposited as local fallout within a few hours after detonation. The fission products in the cloud and fallout may be as low as the equivalent of 20 tons for each device used. From tabulations of fission product production per kiloton of fission a rough list of fission products is given. Radionuclides having relatively long half-lives, such as ^{90}Sr and ^{137}Cs, are important from the standpoint of one-term internal radiation exposure. However, they are released in amounts which are small compared to the other radionuclides. (BBB)

21850 BIBLIOGRAPHY OF UNDERGROUND NUCLEAR EXPLOSIONS DURING THE PERIOD JANUARY 1966 TO DECEMBER 1967. Perilli, Maria Luisa. Com. Naz. Energ. Nucl., Notiz., 14: No. 12, 103-8(Dec. 1968). (In Italian).

The descriptions, civilian applications, mineralogy, radioactive contamination, and the scientific technologies for underground nuclear explosions from January 1966 to December 1967 are listed in a bibliography with 227 references. (J.C.W.)

Facilities and Equipment

Refer also to abstracts 21926, 21932, 22518, 22531, 23043, 23044, and 23184.

21851 (AAEC/TM-488) CALIBRATION OF THE AAEC STANDARD THERMAL NEUTRON FLUX FACILITY. Parry, J. K.; Urquhart, D. F. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1968. 43p. Dep.

The Australian Atomic Energy Commission (AAEC) standard thermal neutron flux facility contains two, ten-curie Pu-Be neutron sources, embedded in a 1.12 m dia × 61 cm high cylindrical paraffin wax reflector, at points 24 cm from the axis. The sources are on opposite sides of a central rectangular graphite moderator (48 cm high × 42 cm × 31 cm) containing a central irradiation cavity 12.7 × 12.7 × 5.1 cm. The conventional thermal neutron flux below the cadmium cut-off energy at the center of the irradiation cavity was $1.387 \pm 0.024 \times 10^{4}$ cm^{-2} sec^{-1} on April 21, 1967. This value was obtained by an absolute measurement in which the ^{198}Au activity produced in gold foils was measured by the $4\pi\beta$-γ coincidence method. This value was found to be in good agreement (within ±0.5%) with values obtained by comparing the AAEC flux with overseas standards. Measurement showed the neutron temperature in the cavity to be 18.5 ± 7°C above the moderator temperature. (auth)

21852 (AECL-2279) ABSTRACTS OF CANADIAN PATENTS ON THE PRODUCTION OF HEAVY WATER. Armstrong, F. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Revised Jan. 1969. 38p. Dep. CFSTI. CAN $1.00.

With a plant in the commissioning stage at Glace Bay, Nova Scotia and another under construction near Port Hawkesbury, Nova Scotia, Canada is becoming a major producer of heavy water. Each of these plants has a capacity of 400 tons per year. A third plant with the same annual production and scheduled for operation in 1972 has been approved. It will be constructed on the same site as the reactor now in operation at Douglas Point on Lake Huron. A collection of patent abstracts is presented which is divided into three groups according to the nature of the production process and includes distillation processes, isotopic-exchange processes, and water-electrolysis processes. Abstracts of fifty-seven patents covering the period from 1937 to January 1969 are presented. (auth)

21853 (AECL-3221) PROSPECTS FOR 44 PERCENT CYCLE EFFICIENCY FROM 400°C (750°F) STEAM IN LARGE ELECTRIC GENERATING STATIONS. Lewis, W. Bennett (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Dec. 1968. 22p. (DM-96). Dep. CFSTI. CAN $1.00.

Current trends towards large capacity nuclear power stations point towards high steam pressure and thereby high steam cycle efficiency. By putting together the best of current practice without any technical break-through, a gross steam-cycle efficiency of

44% is estimated to be practicable from 2500 psi steam at 750°F. Steam at even higher pressure 3500 psi has in the past few years come to predominate in large fossil fuelled generating plants at 1000°F. At lower temperatures, however, due to the special characteristics of supercritical steam, such higher pressures confer no advantage in conventional turbines. The optimum pressure has not been established but probably lies in the range 2466 to 2900 psi for steam limited to 752°F as the maximum temperature. It is believed that such steam can be generated from organic-cooled heavy-water-moderated reactors. The suggested cycle is developed from that used in the Douglas Point nuclear generating station. Suggestions are made for turbine characteristics and feedwater heating systems that could lead to still higher efficiency. (auth)

21854 (CONF-680821-, pp 339-41) CLEAN ROOM FIRE PROTECTION: TWO YEARS LATER. Keigher, D. J. (Richland Operations Office (AEC), Wash.).

Fire-hazard problems associated with the current design and operation of clean rooms, white rooms, and similar ultra-clean facilities are reviewed. (auth)

21855 (IN-1271) PILOT-PLANT TESTING OF A TWO-PHASE VORTEX FLUID AMPLIFIER FOR LIQUID FLOW CONTROL. LaMont, P. E. (Idaho Nuclear Corp., Idaho Falls). Mar. 1969. Contract AT(10-1)-1230. 21p. Dep. CFSTI.

Pilot-plant tests were conducted to evaluate a vortex restrictor for use as a substitute flow control device in a radioactive slurry feed system in which mechanical control valves have been plugged by suspended solids. The restrictor was operated satisfactorily for 1169 hours using a mock-up of the Waste Calcining Facility feed system; successful flow control was obtained without failure due to plugging or erosion in the restrictor. Air was used to regulate the flow rate and to avoid any dilution of the slurry. This device performed at least as well as the more expensive mechanical valve in the particular application for which it was tested. (auth)

21856 (NYO-3930-4) LIQUID METAL BEARINGS TECHNOLOGY FOR LARGE, HIGH-TEMPERATURE SODIUM ROTATING MACHINERY. Progress Report, November 1, 1968–January 31, 1969. Arwas, E. B.; Hoogenboom, L.; Kissinger, C.; Newell, R.; Orcutt, F. K.; Waldron, W. D. (Mechanical Technology Inc., Latham, N. Y.). Mar. 1969. Contract AT(30-1)-3930. 36p. (MTI-69-TR-18). Dep. CFSTI.

Progress is reported on the development of liquid metal bearing technology for large high temperature sodium rotating machinery. Work on the optimization of the shrouded step bearing configuration was conducted, leading to the selection of the principal design parameters including step depth and sealing land geometries for the desired ranges of clearance ratio and Reynolds Numbers (up to 0.003 ″/″ and up to 60,000 respectively). This optimization was made for maximum radial stiffness of each bearing pad for motions normal to the centerline of the pad. Performance calculations for plain and stepped pads, including turbulence and fluid inertia effects, were extended for production runs by addition of appropriate subroutines. In-house development of proximity (film thickness) measuring transducers suitable for operation in liquid metal ambient at elevated temperatures was continued. Furnace tests of the completed transducers were made over the temperature range from room temperature to 1000 F, and showed stable and repeatable probe characteristics. Ageing tests of the core-coil combination were also made in cyclic temperature tests over a temperature range up to 1200 F. These showed inductance changes of less than 1% per cycle. Extended duration tests at elevated temperatures were also made showing no measurable inductance changes at 1000°F and approximately a 1% inductance change after 24 hours at 1200°F. Cyclic pressure tests of the shaft mounted probe version were completed. These showed no damage to either the diaphragm or its coating. They did, however, indicate unacceptably high changes in sensitivity due to compacting of the dielectric material between the diaphragm and the motion sensing capacitance element. Accordingly, the design of the shaft mounted transducers was modified to eliminate this problem. Analysis and design of the test rig for conducting the tests of 12″ diameter sodium lubricated bearings were continued. All analyses of the test rig elements were completed. Detailing and checking of the upper shaft support structure, the sodium containment vessel and the loader mechanism were completed. Detailing of the test bearing support assembly, the loader bearing assembly and the main load support assembly were also completed. Mechanical design of the rotor, cover gas seal and thermal transition piece was continued. The loop design and specifications were completed earlier and released for fabrication. (R.C.K.)

21857 (ORNL-4256) DESIGN OF ENGINEERING-SCALE SOLEX EQUIPMENT. Snider, J. W. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 33p. Dep. CFSTI.

Two engineering-scale solvent extraction facilities utilizing the sol-gel amine extraction process (Solex process) have been designed and installed. The first is a facility (the Th Solex Development Laboratory) for studying thorium and depleted uranium flowsheets, and the second is a facility (the Pu Solex Development Laboratory) for studying ^{233}U and ^{239}Pu flowsheets. Scale-up of the process equipment from laboratory to engineering size required the design of three specific items. The first was a multistage cocurrent backmix reactor for contacting the aqueous phase (a dilute nitrate feed stream) and the organic phase (Amberlite LA-2 in n-paraffin). The second was an interstage digester for heating the aqueous phase for periods of time approaching 30 min. Both the extraction and the digestion steps must be accomplished in a plug flow reactor because the process is sensitive to fluid elements that have not been permitted the proper holdup time. The third was a recirculating vacuum evaporator for concentrating the dilute hydrosol prior to formation of microspheres. The important design requirements for each equipment item, and the specific design of the components, are described. (auth)

21858 (ORNL-TM-2455) REDESIGN OF A HIGH-TEMPERATURE ENGINEERING-SCALE FACILITY FOR DETERMINING STEAM–GRAPHITE REACTION RATES. Helms, R. E.; Neill, F. H.; Richardson, D. M.; Taylor, E. R. (Oak Ridge National Lab., Tenn.). Mar. 1969. Contract W-7405-eng-26. 19p. Dep. CFSTI.

The ORNL engineering-scale facility for determining steam-graphite reaction rates was redesigned to permit exposure of large test specimens of graphite to flowing steam at high temperatures. The redesigned facility will permit exposure of a 2-in.-OD, $\frac{1}{2}$-in.-ID, $26\frac{1}{4}$-in.-long graphite specimen to steam at temperatures up to 2732°F, pressures up to 150 psig, and steam flow rates up to 125 lb/hr. A sample and gas analysis system is provided to determine the total production of gaseous products; however, the changes produced in the graphite specimen will be further evaluated by physical inspection techniques following exposure to steam at the selected test temperatures. (auth)

21859 (ORNL-TM-2512) WRIST-ACTION MANIPULATORS FOR SHIELDED GLOVE BOXES. Morgan, M. T. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 12p. Dep. CFSTI.

Commercial manipulators for use with shielded glove boxes do not have the dexterity necessary for many operations. A wrist-action manipulator is described that will perform many operations which were not possible with the old style manipulators, and will also reach areas in the box which were previously inaccessible. (auth)

21860 (ORNL-TM-2526) EXPERIMENTAL AND ANALYTICAL INVESTIGATIONS OF THE STRUCTURAL BEHAVIOR OF NOZZLE-TO-SHELL ATTACHMENTS. Greenstreet, W. L.; Gwaltney, R. C. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 47p. Dep. CFSTI.

Experimental and analytical investigations of nozzle-to-shell attachments are described. Both elastic and plastic behavior of single nozzle-to-shell attachments were studied, as well as elastic behavior of multiple nozzles in closely spaced clusters. The studies being made and the contributing roles of the organizations engaged in these studies are reported. (auth)

21861 (SC-RR-69-159) AUTOROTATION CHARACTERISTICS OF VARIOUS SHAPES IN SUBSONIC AND HYPERSONIC FLOWS. Bustamante, A. C.; Stone, G. W. (Sandia Labs., Albuquerque, N. Mex.). Apr. 1969. 42p. Dep. CFSTI.

An experimental and analytical study which was conducted to investigate the dynamic characteristics of autorotating configurations in subsonic and hypersonic flows is described. For these studies, a new technique was developed for calculating dynamic stability derivatives. (auth)

21862 (TID-4100(Suppl.50)) ENGINEERING MATERIALS LIST. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Apr. 1969. 35p. DTIE Free.

Twenty-two packages of engineering drawings are presented on the K-II zonal centrifuge, MPF storage loop, spent fuel shipping cask, damper, environmental sample chamber, nineteen-rod cluster fuel element, pressure transducer, end window G-M Survey Meter, FET electrometer, counting shield, sphincter seal, geophone seal mounting, pitot tubes, pulsed power supply, camera filter attachment, portable beta-gamma foot monitor, miniature neutron detector, PDP-8 neutron spectrometer interface, electronic air column reading device, low pressure gas threshold counters, high pressure gas differential counter, and liquid differential counter. (R.C.K.)

21863 (TID-24058) THE COMMERCIAL PROSPECTS FOR SELECTED IRRADIATED FOODS. Yates, D. M.; Collings, G. W.; Kinne, I. L.; Kircher, J. R.; Litchfield, J. H.; Wilhelmy, O. Jr. (Battelle Memorial Inst., Columbus, Ohio). Mar. 1968. Contract AT(49-11)-2797. 90p. GPO $0.50.

The factors that affect commercialization of food irradiation are discussed. It was found that the most important of these are capital investment and operating costs. Other factors that affect food irradiation costs are heterogeneity and configuration of food products, dose level, throughput, and the efficiency with which radiation processing is performed. The food categories selected for the study were dehydrated vegetables, bananas, marine products, poultry, beef, and pork and pork products. The outlook for the radiation processing of each of these food products is summarized. It was concluded that the benefits of irradiation appear to be related to product quality and marketing advantage rather than cost reduction. A comparison of the irradiation benefits with irradiation costs is, therefore, difficult to make. Success depends on the ability of the processing firm to market the product and obtain consumer acceptance. (R.C.K.)

21864 (Y-1629) HIGH-TEMPERATURE FURNACE FOR HIGH-PRESSURE ARGON GAS OPERATION. St. Onge, C. D.; Pohto, H. A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Feb. 17, 1969. Contract W-7405-eng-26. 22p. Dep. CFSTI.

A furnace has been designed that operates in an existing Y-12 Plant pressure vessel at 1,700°C and 20,000 psi in an argon atmosphere. The furnace could be constructed at a relatively low cost and would have a reasonable service life. (auth)

21865 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS. Cook, R. K.; Hosegood, S. B. (to United Kingdom Atomic Energy Authority). British Patent 1,147,064. Apr. 2, 1969. Filed June 15, 1965.

Reference is made to nuclear reactors in which the entire primary coolant circuit, including the heat exchangers, is located inside the reactor vessel. There are obvious advantages in arranging the heat exchangers so that they can be removed and replaced, but entry to the reactor vessel to make or break pipe joints may be difficult or impossible. A heat exchanger system is described which allows installation or removal without the need for entry of personnel into the vessel, since all pipe joints can be made externally. The system comprises a vessel having an access opening, and a plurality of elongated tube arrays. Each array is small enough to pass through the access opening, and all arrays include riser pipes which protrude through the opening after the arrays are positioned within the vessel; at least one array is out of alignment with the opening. Some variants of the system are described. Each tube array may be a complete boiler unit, containing economiser, evaporator superheater and reheater sections, the individual arrays being connected in parallel to headers outside the vessel. (UK)

21866 HEAT EXCHANGERS. (to Sulzer Brothers Ltd.). British Patent 1,147,046. Apr. 2, 1969. Priority date Apr. 7, 1965, Switzerland.

A heat exchanger that is used in a nuclear reactor is described. The heat exchanger consists of a duct for the reactor coolant, a grating which extends across the duct, and a number of heat exchange units arranged side by side parallel to each other. The units are carried by the grating and arranged so that spaces between adjacent units and between units and the wall of the duct are bounded at least at one end partially by bars of the grating. The bars between the units and the duct wall are connected by a movable seal to the duct wall so that the duct is divided approximately at the level of the grating into two spaces. Units in one space communicate by apertures in the grating with the other space. (F.S.)

21867 JET PUMP. (to General Electric Co.). British Patent 1,147,623. Apr. 2, 1969. Priority date May 28, 1965, United States.

A jet pump and a reactor using the jet pump in the pumping system are described. The pump consists of an elongated hollow body with an inlet at one end and an outlet at the other. A nozzle adjacent to the inlet directs a jet of fluid into the inlet. The hollow body contains a mixing chamber opening toward the inlet and a diffuser connected in series with, but downstream from, the mixing chamber and opening toward the outlet. A means is provided for sensing the pressure of the fluid in the hollow body. The pump is used to pump the reactor coolant through the reactor cores. (F.S.)

21868 MICROSTRUCTURE OF ALUMINA AND BERYLLIA CERAMICS. Ferreira, L. E. (Coors Porcelain Co., Golden, Colo.); Weaver, R. E. pp 239-50 of Special Ceramics 4. Popper, P. (ed.). Stoke-on-Trent, Eng., British Ceramic Research Association, 1968.

From 4th Symposium on Special Ceramics, Stoke-on-Trent, England. See CONF-670731.

Photomicrographs of eighteen alumina and six beryllia ceramics are presented for comparison. Three specimen preparation methods were used: inked replicas of as-fired surfaces, polished sections, and thin sections. The inked replica technique is described. Some details relating to processing, properties and applications of these materials are given. (auth) (UK)

21869 VAPOUR GENERATORS. Kagi, Jakob (to Sulzer Brothers Ltd.). British Patent 1,147,299. Apr. 2, 1969. Priority date Dec. 9, 1966, Switzerland.

A vapor generator which may be used in a steam generator in a reactor is described. The vapor generator has a number of tubes connected in parallel with respect to the flow of the working medium to be evaporated. The evaporation zones of different tubes are at different heights. Some of the tubes are connected to pressure reducers which produce pressure drops substantially independent of the rate of flow and arranged to approximately equalize pressure drops across heated portions of the various tubes. (F.S.)

21870 FEEDBACK CONTROL OF THE BUCKLING INSTABILITY IN AN AXIALLY COMPRESSED THIN ELASTIC BEAM. Jefferis III, Raymond Palmer. Philadelphia, Univ. of Pennsylvania, 1968. 125p.

Thesis.

A thin elastic beam in axial compression is shown, by means of Bers-Briggs diagrams, to be a statically unstable system when the longitudinal compressive force exceeds a critical value determined by the beam characteristics and boundary conditions. The consequent buckling instability may be averted by applying a controlled transverse restoring force, spatially distributed over the beam surface, proportional to the beam displacement. This linear distributed parameter control problem is formulated as a Fredholm integral equation of the second kind. The Green's function kernel is then expanded in a truncated Fourier series of normal vibratory modes, and the resulting approximate solution obtained by the Galerkin method yields the critical control loop gain. Experimental results accurately confirm the theoretically predicted gain values. The same gain values are subsequently obtained when the equation of motion is expressed in state variable form and the resultant matrix Fredholm integral equation solved. Applications suggested include controlled stabilization of moving steel sheet in rolling mills, vibrating aerodynamic surfaces, neutron flux density, fluid jets, and other unstable distributed systems. (Disser. Abstr.)

21871 INCINERATOR EQUIPMENT ARRANGEMENT (Engineering Materials). (Richland Operations Office (AEC), Wash.). (CAPE-1860).

5 drawings.

The incinerator facility and auxiliary equipment designed to handle combustible waste contaminated with plutonium at the Hanford Plutonium Finishing Plant are described. The incinerator facility is 36 by 56 ft and contains the incinerator room, a room for storage of drums and another room for storage, and a change room. The incinerator room contains the incinerator, glove boxes, instrument panel, off gas scrubber, and an ash separator. Ash from the incinerator which retains plutonium values is treated for recovery in the Plutonium Reclamation Facility. (For details see TID-4100(Suppl.53)). (F.S.)

21872 BOUNDARY LUBRICATION. AN APPRAISAL OF WORLD LITERATURE. Ling, F. F.; Klaus, E. E.; Fein, R. S. (eds.). New York, American Society of Mechanical Engineers, 1969. 584p.

A comprehensive and critical appraisal of the world literature on boundary lubrication is presented. Boundary lubrication is discussed under the following subjects: friction at dry surfaces, mechanisms of wear, physics and chemistry of surfaces, catalysis studies related to boundary lubrication, boundary lubrication, fretting, physical properties of lubricants, requirements of materials for sliding and rolling contact, transition from boundary lubrication to elastohydrodynamic lubrication, and test methods. A bibliography, containing 2711 abstracts to world literature on boundary lubrication, is included. Abstract author and abstract subject indexes are also included. (R.C.K.)

21873 METHOD OF AND APPARATUS FOR FORMING TUBES. (to Sandvikens Jernverks Aktiebolag). British Patent 1,149,822. Apr. 23, 1969. Priority date Feb. 1, 1966, Sweden.

The equipment and method for cold rolling zirconium and zirconium base alloys for the production of tubes are described. The zirconium base alloys consist of zirconium with additions of one or more of the following: chromium, copper, iron, molybdenum, nickel, niobium, or tin. (F.S.)

21874 IMPROVEMENTS IN AND RELATING TO A SEALING PLUG. Fortin, Marcel; Lemer, Jacques; Vertut, Jean (to Commissariat a l'Energie Atomique). British Patent 1,149,510. Apr. 23, 1969. Priority date Aug. 5, 1966, France.

A sealing plug for an opening in the wall of a shielded enclosure such as a hot cell is described. When the opening consists of at least two portions with different diameters which form an annular shoulder, the sealing plug is adapted to fit the opening. Two annular channels are formed and spaced axially apart. Guide rings in the channels project radially beyond the surface of the plug. The guide rings fit closely in each portion of the opening. (F.S.)

21875 REINFORCEMENT MEMBER FOR SHIELDED ENCLOSURE. Fortin, Marcel; Lemer, Jacques; Vertut, Jean (to Commissariat a l'Energie Atomique). British Patent 1,149,509. Apr. 23, 1969. Priority date Aug. 4, 1966, France.

A reinforcement member which is placed within an opening formed by the emission of one or more of the constituent bricks in the wall of a shielded enclosure, such as a hot cell, is described. The member consists of a tubular element which extends through the wall with annular projections in planes at right angles to the axis of the element. The projections are axially spaced at uniform intervals with a pitch which is equal to $\frac{1}{2}$ of the pitch of the saw-tooth grooves and recesses of those of the lead bricks of the wall. (F.S.)

21876 A DEVICE FOR FIXING A REMOVABLE COMPONENT TO A RIGID WALL. Fortin, Marcel (to Commissariat a l'Energie Atomique). British Patent 1,149,495. Apr. 23, 1969. Priority date July 22, 1965, France.

A device for effecting a connection between a rigid wall, such as that of a glove box or hot cell, and a removable component, such as a glove or flexible bellows, and to fix the component to the rigid wall is described. The device consists of two rings one slidable within the other. One ring is connected to the component and one to the wall. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 21865, 21866, 21869, 23877, 23891, 23902, 23919, 23980, 23986, 23987, 24034, 24040–24042, 24044, and 24046.

21877 (AECL-3028) COLLAPSE MECHANISM OF FLUIDIZED BEDS SUBJECTED TO SUDDEN LOSS OF LIQUID FLOW. Armstrong, R. K.; MacFarlane, R.; Trupp, A. C. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). June 1968. 34p. Dep. CFSTI. CAN $1.00.

Experiments were conducted to determine the collapse behavior of a fluidized bed of spheres subjected to sudden loss of flow of the supporting liquid. Observations showed the particles fell en masse and the mobile phase maintained the starting porosity. Following an initial short acceleration period, the particles fell at a constant limiting velocity (V_l) with respect to the tube which was found to be a function of the single sphere terminal velocity (V_T) and the initial porosity (ϵ). Experimental techniques for determining V_l are described and the data presented. Under conditions of Newton flow and negligible wall effects, the collapse velocity, V_l, was given by: $V_l = 0.826(V_T)^{1.18}(\epsilon)^{2.28}$, V_l and V_T = m/s. Particle mechanics theory is used to demonstrate the mobile phase is actually fluidized during the collapse. The application of the results to the design (hazards analysis) of a liquid fluidized bed nuclear reactor is discussed briefly. (auth)

21878 (CONF-680118–1) DESIGNING FOR TWO-PHASE FLOW. PART 1. OPENING ADDRESS AND GENERAL. (National Engineering Lab., Glasgow (Scotland)). Jan. 1969. 9p. (NEL–385). Dep.

The opening address of the meeting on two-phase flow in the vertical tubes of boilers, evaporators, heat exchangers, and similar equipment is presented. (UK)

21879 (CONF-680118–2) DESIGNING FOR TWO-PHASE FLOW. PART IV. PREDICTION OF PRESSURE LOSSES AT CHANGES OF SECTION, BENDS AND THROTTLING DEVICES. (National Engineering Lab., Glasgow (Scotland)). Jan. 1969. 22p. (NEL–388). Dep.

Relationships are developed for the flow of two-phase mixtures through changes of flow cross sections, including recommendations for predicting pressure losses in these situations and through valves and pipe bends. (auth)

21880 (CONF-680118–3) DESIGNING FOR TWO-PHASE FLOW. PART II. VOID FRACTION PREDICTION UNDER SATURATED CONDITIONS. (National Engineering Lab., Glasgow (Scotland)). Jan. 1969. 47p. (NEL–386). Dep.

A review is given of some of the methods of measuring void fraction, together with some deduced correlations. A simple expression is given, based on a relative velocity model, for the prediction of void fraction over a fairly wide range of natural circulation conditions; this expression takes the form $x_a = cx_v$, where c is dependent on no-slip flow conditions. The proposed correlation is compared with the results of other workers, and close agreement obtained. (auth)

21881 (CONF-680118–4) DESIGNING FOR TWO-PHASE FLOW. PART V. HEAT TRANSFER DURING TWO-PHASE FLOW. (National Engineering Lab., Glasgow (Scotland)). Jan. 1969. 26p. (NEL–389). Dep.

Correlations and procedures for calculating two-phase heat transfer in evaporating systems are reviewed. (auth)

21882 (CONF-680118–5) DESIGNING FOR TWO-PHASE FLOW. PART III. PREDICTION OF FRICTION PRESSURE GRADIENTS. (National Engineering Lab., Glasgow (Scotland)). Jan. 1969. 32p. (NEL–387). Dep.

Methods of calculating frictional two-phase pressure gradients are discussed and numerical examples given. (auth)

21883 (INR–949) ELECTRIC RESISTANCE ANALOGY FOR HEAT TRANSFER STUDIES. PART II. THE ANALYSIS OF ACCURACY. Strupczewski, A. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 59p. Dep.

Theoretical and experimental accuracy studies of the Resistance Analog Computer are described. Space and time truncation errors are discussed and the accuracies of RAC components measured and their influence upon overall solution accuracy computed. Several problems with known analytical solutions are solved and the predicted solution accuracy is compared with the value obtained experimentally. The comparison gives satisfactory results, proving soundness and usefulness of accuracy assessment methods discussed. (tr-auth)

21884 (ORNL-TM-2122) AN EXPERIMENTAL STUDY OF THE CRITICAL HEAT FLUX FOR LOW PRESSURE BOILING WATER IN FORCED CONVECTION IN A VERTICAL SEVEN HEATER ROD BUNDLE. Jones, J. K. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 137p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The effects of inlet subcooling, pressure level, mass flow, and shroud heating on the flow boiling crisis with water at near-atmospheric pressure levels in upward flow through a seven-rod bundle were studied. Surface-to-surface rod spacing was restricted to $\frac{1}{16}$ in. The boiling crisis was achieved by maintaining constant the boiler heat rate and the inlet fluid temperature while incrementally reducing the inlet mass flow. The onset of critical conditions was indicated by temperatures measured on the longitudinal axis near the outlet end of the heater rods and by leakage currents measured across the heater insulation between the heating element and the central thermocouple sheath. The first method was found to be more precise, and the results reported are for the incipient boiling crisis as manifested by a 50°F rise in the central temperature of the heater rod. The critical heat flux in a seven-rod bundle could be increased (for constant inlet subcooling) by increasing the mass velocity, the system pressure, and the heat rate to the external shroud heater. The critical heat flux data agreed well with limited critical heat flux data obtained with potassium in a similar geometry. Insight may be gained into the parametric trends of the flow boiling crisis with potassium from the results of this investigation. A comparison of the results indicated a consistent relationship between the critical heat flux and the exit quality; namely, the critical heat flux increased with decreasing quality. This increase was significant when the exit quality was reduced below 50 percent. Data obtained when the boiler shell was not heated indicated the flow boiling crisis was signaled first by a peripheral heater rod and in no case did the central rod give an initial indication. However (for the data with the boiler shell heated), when the heat flux was approximately equal on all heated surfaces, the central rod did give some initial indication of the boiling crisis. The axial location of the crisis on a heater surface was for all cases near the end of the heated length (indicating a film depletion type of crisis) which was demonstrated by a scale buildup in this area after an extended operation period. Accompanying the scale buildup, there was a significant increase in the critical heat flux. (auth)

21885 (WAPD-TM-777) RADIATION TRANSFER ACROSS A SPHERICAL PORE IN A LINEAR TEMPERATURE GRADIENT (LWBR DEVELOPMENT PROGRAM). Marino, G. P. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1969. Contract AT-11-1-GEN-14. 12p. Dep. CFSTI.

The conductivity, K_r, of a spherical void in a linear temperature gradient due to radiation is calculated by integration of the general expression for diffuse radiation between two surfaces of arbitrary orientation. The spherical geometry allows an exact evaluation of the phenomenon without resorting to approximate expressions for the radiant heat flux. The resulting expression for K_r is $\frac{3}{4}$ of the approximate value obtained by Loeb. (auth)

21886 THERMAL DIFFUSIVITY AND PRANDTL NUMBER OF LIQUID MERCURY AND POTASSIUM FROM MELTING POINT TO CRITICAL POINT. Grosse, A. V. (Temple Univ., Philadelphia). Contract AT(30-1)-2082. J. Inorg. Nucl. Chem., 31: 1289-1301(May 1969). (NYO-2082-16).

The thermal diffusivities and Prandtl numbers are compared with an ideal liquid-argon. The values were calculated for a substantial part of the liquid range from experimental data of all variables defining the thermal diffusivity and Prandtl number. They were estimated up to the critical point based on published data, except that the specific heats were independently estimated up to the critical point. In spite of the large range of absolute values for the Prandtl number (by a factor of over 500) between K and Ar, the agreement between the curves of the two metals and Ar is gratifying. (auth) (UK)

21887 STATISTICAL TECHNIQUES FOR EVALUATING EXPERIMENTAL PERFORMANCE RESULTS ON A BATCH OF HEAT EXCHANGER ELEMENTS. Horn, G. (Central Electricity Generating Board, Berkeley, Eng.); Atherton, A. Trans. Inst. Chem. Eng. (London), 47: T43-51(1969).

Mass produced finned elements forming the heat transfer surfaces of heat exchangers or nuclear reactors may differ slightly due to manufacturing tolerances. These differences can affect the heat transfer and pressure drop performance of production elements and resulting variations may need to be taken into account in the design of high performance plant where control of cost, rating, or operating temperature is critical. Experimental results are presented for the heat transfer and pressure drop performance of a batch of production finned tubes tested in axial flow. These results are used to illustrate statistical techniques for determining whether the observed performance differences are real when assessed against the magnitude of the experimental error. (auth) (UK)

Isotope Technology

Refer also to abstracts 21728, 21846, 21849, 21863, 21975, and 22536.

21888 (AD-675039) RADIOACTIVITY RELEASE FROM RADIONUCLIDE POWER SOURCES. VIIa. DISSOLUTION STUDIES OF PLUTONIUM DIOXIDE IN THE OCEAN-5-MONTHS' EXPOSURE. Kubose, Donald A.; Lai, Ming-Gon; Goya, Harry A.; Cordova, Herman I. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 16, 1968. 26p. (USNRDL-TR-68-74). CFSTI.

Post-ocean-exposure examinations were made on plutonium dioxide microspheres recovered after a 5-month exposure on the bottom at a depth of 50 feet off San Clemente Island. These examinations established that approximately 70 percent of the microspheres became encrusted with marine growth. Determination of the distribution of the microspheres and absorbed activity in the ocean-bottom material was made in addition to post-exposure laboratory dissolution measurements, microscopic examination and x-ray diffraction measurements. (auth) (USGRDR)

21889 (BNWL-994) ^{147}Pm RADIOISOTOPE APPLICATION PROGRAM AMSA HEAT SOURCE. Final Report. Davis, N. C.; Brite, D. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1969. Contract AT(45-1)-1830. 68p. Dep. CFSTI.

A promethium-147 fueled 60-W thermal source was fabricated for the Air Force for use in heating a navigation device for the Advanced Manned Strategic Aircraft (AMSA) Program. A high strength impact resistant capsule was designed, and a capsule fabrication process was developed. A series of dummy (SM_2O_3 stand-in for $^{147}Pm_2O_3$) capsules were fabricated, impact tested, and destructively evaluated to demonstrate process quality and to determine impact strength. Process and quality control inspection procedures were established and the $^{147}Pm_2O_3$ fueled capsule was produced and delivered to the Air Force for laboratory testing and flight demonstration of AMSA navigational equipment. (auth)

21890 (JUL-548-PC) A 3-STAGE MULTIPURPOSE THERMAL DIFFUSION SEPARATION CASCADE. Bukow, H.-H.; Groth, W.; Murrenhoff, A. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie). Aug. 1968. 152p. (In German). Dep.

Construction and operation of a 3-stage isotope separation cascade, consisting of 7 thermal diffusion columns for gases designed for multipurpose operation, are described. The working data of the single columns and the cascade for transient and steady-state operation were measured for the $^{14}N_2{}^{14}N^{15}N$ separation. The experimentally determined data are compared with the results of theoretical calculations. Optimization of the conditions of operation is discussed according to the theory of G. Dickel and coworkers. (auth)

21891 (MLM-1530) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: OCTOBER-DECEMBER 1968. (Mound Lab., Miamisburg, Ohio). Apr. 7, 1969. Contract AT-33-1-GEN-53. 56p. Dep. CFSTI.

Research progress is reported on carbon isotope separation, stable gaseous isotope separation, thermal diffusion, and low-temperature processes. (M.C.G.)

21892 (MLM-1626) FINES ANALYSIS OF PLUTONIUM DIOXIDE MICROSPHERES AFTER IMPACT. Bonnell, P. H. (Mound Lab., Miamisburg, Ohio). Apr. 18, 1969. Contract AT(33-1)-Gen-53. 21p. Dep. CFSTI.

Seven capsules containing sized $^{238}PuO_2$ microspheres were impacted into concrete, granite, and sand targets at velocities from 102 to 456 ft/sec (31 to 139 m/sec). The damage to the microspheres and percentage of fines produced were determined. The percentage of fines (particles 0 to 44 μm in diameter) increased with increasing velocity to a maximum percentage between 50 to 55%. (auth)

21893 (N-68-37260) GAMMA HEATING IN THIN HEAVY-ELEMENT ABSORBERS. Lynch, John H.; Crum, Richard J.; Reilly, Harry J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct. 1968. 20p. (NASA-TM-X-1680). CFSTI.

The ratio of gamma heating per gram of tungsten to gamma heating per gram of water was calculated for the case of a thin tungsten detector in a water shield. One dimensional transport theory calculations were used to obtain response polynomials which predict this ratio as a function of source energy, shield thickness, and detector thickness. Electron transport effects were also examined. Useful results are presented in the form of graphs. (auth) (STAR)

21894 (ORNL-tr-1870) ENRICHMENT OF NATURAL AND RADIOACTIVE KRYPTON ISOTOPES IN A THERMAL DIFFUSION COLUMN. Meinrenken, J. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Z. Naturforsch., 22a: 1261-6 (1967). 11p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 43199. (R.C.K.)

21895 (PINSTECH/RIPD-1) PRODUCTION OF THE FIRST COMMERCIAL BATCH OF RADIOACTIVE ISOTOPES AT PINSTECH. Rahamn, Md. Matiur; Rahman, Abdur; Mubarak, M. A. (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Radioisotope Production Div.). 1968. 16p. Dep.

The production and handling of the first shipment of a radioisotope, namely ^{24}Na, for domestic diagnostic use, accomplished at the Pakistan Research Reactor is described. (L.C.L.)

21896 (RT/ING-(68)21) OPTIMIZATION OF A GASEOUS DIFFUSION SETUP FOR ENRICHMENT OF URANIUM. Calori, F.; Scuricini, G. B.; Venditti, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 54p. (In Italian). Dep.

An optimization is given in order to assess the different arrangements (squared and three/four steps squared-off cascade) for a 700 t U/yr gaseous diffusion enrichment plant. The influence on the main design parameters of the plant is shown for different values of the assumed cost functions. (auth)

21897 (SC-DR-69-60) SNAP-27 FUEL CAPSULE ASSEMBLY RADIANT HEAT TESTS. Keller, L. L. Jr. (Sandia Labs., Albuquerque, N. Mex.). Mar. 1969. 31p. Dep. CFSTI.

Three reference design full scale SNAP-27 fuel capsule assemblies were subjected to thermal pulses in radiant heat arrays to investigate their reaction to a fireball/afterfire resulting from launch pad abort, and an earth orbit decay for both lateral spinning and side-on stabilized modes. Photographs of the test setups and pertinent test data are presented. (auth)

21898 ACTINIDES FOR RADIONUCLIDE BATTERIES. Born, H.-J. (Technischen Hochschule, Munich). Atompraxis, 15: 32-4(Jan.-Feb. 1969). (In German).

The possibilities of converting the radiation energy of radionuclides and the technical requirements of radionuclide batteries are described. The properties of ^{227}Ac, ^{242}Cm, ^{244}Cm, ^{210}Po, ^{238}Pu, ^{228}Th, and ^{232}U which are suitable for this type of application are discussed. (auth)

21899 HIGHER OUTPUTS AND EFFICIENCIES FOR NUCLEAR BATTERIES. Matheson, W. E. Space/Aeronaut., 51: 76-9 (Feb. 1969).

Previous drawbacks of nuclear batteries have been largely overcome in the Isomite and Betacel nuclear batteries tested in prototype form during 1968. The Isomite is a thermal battery with a thermionic converter powered by nuclear heating, while the Betacel is an electronvoltaic battery that derives its power from the interactions of nuclear decay particles. An early Isomite design of 4 MW output, operating for only 50% of one half-life of its fuel, provides 200 Wh/lb with ^{147}Pm and 7 kWh/lb with ^{238}Pu. The Betacel battery, whose specific energy increases with power output, provides 500 Wh/lb at an output of 10 MW. Improvements in specific energy are projected for both batteries: by a factor of 2 for the Betacel and 3 or more for the Isomite. The Betacel has an appreciable efficiency advantage at output powers of 1 MW or less, which becomes quite substantial at levels of about 10 μW. The Isomite, on the other hand, for which a wider range of fuels is available, is better suited to very-long-life applications—more than a few years of continuous operation or more than 10 yr of pulsed-load operation. Another advantage of the Betacel is that its basic element is a thin-cell wafer convenient for packaging into multicell units. To achieve the desired output voltage and current capacity, the size of the wafer and the series-parallel connection of the cells are varied. (BBB)

21900 EUROPEAN ENRICHMENT PLANT. Nucl. Eng. Int., 14: 343-5(Apr. 1969).

Future uranium requirements were assessed and the size of plant needed thus estimated. The economics of the three separation methods, diffusion, the nozzle process, and the gas ultracentrifuge, were studied, and their relative merits observed. The centrifuge process appeared to offer the best prospects. (UK)

21901 PROCESS FOR THE PREPARATION OF A RADIOACTIVE SOURCE AND RADIOACTIVE SOURCE AS OBTAINED BY APPLICATION OF SAID METHOD OR A LIKE METHOD. Henry, R.; Levy, V.; Tournier, J. (to Commissariat a l'Energie Atomique). Canadian Patent 801,288. Dec. 10, 1968. Priority date Mar. 10, 1964, France.

A ^{210}Po source was made by neutron irradiation of an alloy of ^{209}Bi. The result is radioactive ^{210}Bi which by β emission yields ^{210}Po. The preparation of a Bi−Mg alloy is carried out by high frequency induction melting and the coupling of the metals in a tantalum or stainless steel crucible with an insulated winding through which an electric current flows. The crucible contains a refractory lining inside of which the metallic charge is placed. The molten state is maintained for one hour in an Ar atmosphere, the temperature attained being about 900°C. It may be allowed to cool slowly or water quenched from 650°C. The resulting alloy contains about 80% Bi which is then subjected to neutron irradiation in a reactor channel. (F.S.A.)

21902 A QUICK DETERMINATION OF PISTON RING WEAR RATE BY MEANS OF TAGGED ^{59}Fe. Liu, C. L.; Juang, K. C. Ho Tsu K'o Hsueh, 6: 75-81(Oct. 1968). (In Chinese).

A technique of engine piston ring wear measurement by means of irradiated piston rings tagged ^{59}Fe in a four cylinder 5kW field generator set is described. The rate of piston ring wear in different operating conditions, (rpm and load) can be definitely determined within 2 to 3 hours of test run. (auth)

21903 THE FABRICATION OF ^{90}Sr TITANATE RADIOACTIVE SOURCES FOR ISOTOPIC GENERATORS. Fradin, J. (Commissariat a l'Energie Atomique, Paris). Newslett. Isotop. Generator Inform. Centre, No. 7, 29-47(Nov. 1968).

Studies, equipment, and results obtained in the preparation of strontium-90 titanate heat sources are described. Problems encountered in selecting encapsulating materials are discussed. The facility, hot cells, and equipment including can cutters, furnaces, grinders, and hydraulic presses are briefly described. (F.S.)

21904 "MARGUERITE II" GENERATOR. Freund, J. Newslett. Isotop. Generator Inform. Centre, No. 7, 23-7(Nov. 1968).

The MARGUERITE II, a radioisotope-fueled thermoelectric generator in the low power range designed for marine and underwater use, is discussed. The $^{90}SrTiO_3$ heat source, thermopile, thermal insulation block, and the biological shield heat sink are described. (F.S.)

21905 MARINE AND SPACE GENERATORS DEVELOPED BY SNECMA. Thery, P. Newslett. Isotop. Generator Inform. Centre, No. 7, 15-21(Nov. 1968).

Three types of French isotopic generators are described. The Marguerite II designed for surface light buoys and underwater ultrasonic buoys is decreased. An improved version of the Marguerite II, with a source of more than 10^5 Ci, is under construction. This nuclear battery will be used in servo-control and servo-actuation systems, telemeasurement systems, remote control applications, and transmission systems. A radioisotope fueled thermoelectric generator equipped with 32 Ge−Si converters and with a ^{90}Sr fuel of 50,000 Ci is under development for use in space. (F.S.)

21906 APPLICATIONS OF ISOTOPIC GENERATORS. Newslett. Isotop. Generator Inform. Centre, No. 7, 11-13(Nov. 1968).

Applications of isotopic generators in beacons and buoys, offshore oil fields, space, and telecommunications are described. The following programs are briefly mentioned: RIPPLE in England; CNES-SNECMA, GISETE, and MARGUERITE in France; BETA in the USSR; BOLKOW in Germany and NUMEC and SNAP in the U.S. (F.S.)

21907 GETER 2-B THERMOELECTRIC ISOTOPIC GENERATOR. Brouee, R. Newslett. Isotop. Generator Inform. Centre, No. 7, 5-10(Nov. 1968).

The principles and uses of radioisotope-powered thermoelectric generators are discussed. An isotopic heat source using strontium-90 titanate, a thermoelectric converter employing bismuth telluride and lead telluride, and the thermal insulation and radiation shielding for a thermoelectric isotopic generator are described. (F.S.)

21908 ISOTOPE SEPARATION BY THERMAL DIFFUSION IN LIQUID METAL. Ott, Aadu (Univ. of Technology, Goteborg). Science, 164: 297(Apr. 18, 1969).

Isotopic enrichment of several percent has been obtained in liquid lithium metal by applying a temperature gradient over a single-stage separation column. For other metals the method should have the highest efficiency, if the metals have low melting points and are liquid over a wide temperature range. (auth)

21909 PREPARATION OF BISMUTH AND ANTIMONY SOURCES FOR BETA SPECTROSCOPY. Purificato, J. A. (Comision Nacional de Energia Atomica, Buenos Aires). Radiochim. Acta, 11: 59(Mar. 1969).

Methods are described for the preparation of ^{207}Bi and ^{124}Sb sources for beta spectroscopy using a standard electroplating cell made of perspex. A solution containing nitric acid, hydrazine sulfate, and sodium lauryl sulfate in distilled water was heated to 70°C and ^{207}Bi solution as $Bi(NO_3)_3$ or ^{124}Sb solution as $SbCl_3$ was added. The plating of Bi was carried out under strong stirring with a current of 30 to 40 mA and a potential of 3 V. The plating of Sb was carried out under moderate stirring with a current of 50 mA and a potential of 4 to 4.5 V. Since the uniformity of the deposits depends strongly on pH, the final pH was 0.4 to 0.5. Five sources of ^{207}Bi and 10 of ^{124}Sb were prepared using these procedures and good yields and uniformity were obtained in all cases. (D.H.M.)

Materials Testing

Refer also to abstracts 21897, 22514, 22582, 22587, 22592, and 23243.

21910 (BNWL–790, pp 13.1-8) FRACTURE MECHANICS EVALUATION OF REACTOR VESSEL STEELS. Mager, T. R.; Hazelton, W. S.; Thomas, F. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.).

Investigations of effects testing radiation on pressure vessel steels are reported. Results of preirradiation fracture toughness tests on 3 of the 4 AEC approved materials, 8 in. thick plate of Type A533B steel, European Forging Grade steel, and a weldment from a heat of A533B Class I steel, are presented. Specimens from 12 in. thick plate of A533B steel were fabricated and delivered for assembly in irradiation capsules. (L.C.L.)

21911 (BNWL-SA–2220) POTENTIAL OF HOLOGRAPHY FOR IRRADIATED MATERIALS TESTING. Brenden, B. B.; Hildebrand, B. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1968. 27p. (CONF-690305–2). Dep. CFSTI.

From Remote Handling and Examination in the Fast Reactor Field Meeting, Idaho Falls, Idaho.

Holography is a technique of imaging which permits interferometric comparisons of a diffusely reflecting object of complex configuration with the same object under a different stress loading for purposes of studying the distribution of strain. Holography has also been applied with considerable success to acoustical imaging. The progress of stress corrosion cracking can be studied by application of a combination of holographic interferometry, acoustical holography and acoustical emission techniques. It also seems likely that holographic interferometry will become a powerful tool for tensile testing. (auth)

21912 (ORNL-TM-2488) INTENSIFYING SCREENS FOR RADIOGRAPHY WITH ENERGIES BETWEEN 70 AND 140 KILOVOLTS CONSTANT POTENTIAL. Wamorkar, R. R.; McClung, R. W. (Oak Ridge National Lab., Tenn.). Mar. 1969. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Lead-oxide screens 0.001 in. thick were investigated to determine their usefulness as radiographic image intensifiers at x-ray energies below the normally accepted limit of about 125 kVcp. Radiographs were made of a stainless steel step wedge (thicknesses from 0.020 to 0.200 in.) with x rays ranging in energy from 65 to 140 kVcp and with varying exposure times. With no specimen on the x-ray film, the attenuation of the x rays exceeded any intensification effect. With a specimen of any thickness there was increased film density with the use of the lead-oxide screens. There appeared to be unexplained fluctuations of the intensification factor as a function of the film density that was achieved. (auth)

21913 SOME PRELIMINARY RESULTS ON TRANSFER METHOD IN NEUTRON RADIOGRAPHY. Azzoni, A.; Pirovano, B.; Tonolini, F. (CISE, Milan). Energ. Nucl. (Milan), 16: No. 4, 46-7(Apr. 1969).

The transfer method in neutron radiography was studied. A well collimated thermal neutron beam impinged on the specimen and the neutrons emerging from the specimen were absorbed by indium foil. An image in the form of a pattern of radioactivity was formed. The foil was placed in close contact with an x-ray film for $\sim$3 half-lives of indium, and developed. When neutron intensity, beam exposure time, detection system, and x-ray film selection are optimized, resolution, contrast, and gamma fogging should be greatly improved. (F.S.)

21914 MEASUREMENT OF SPATIAL FREQUENCY RESPONSE IN γ-RAY RADIOGRAPHY. WEDGE MOVING METHOD. Nojiri, Toshiaki (Industrial Research Inst. of Kanagawa Prefecture, Yokohama, Japan). Radioisotopes (Tokyo), 18: 137-42(Apr. 1969). (In Japanese).

A new method of measuring the response to γ-rays by a combination of x-ray film and Pb intensifying screen which is another component of the γ-ray radiography system is described. A wedge which absorbs γ-rays is moved back and forth in the way that its displacement is sinusoidal; thus penetrating γ-ray doses vary with time by the sine wave. The film is moved at a constant velocity across such a γ-ray beam, so that nearly sinusoidal patterns are developed upon the film as stripes. The contrast of light and shade in the strip patterns determines the response functions of the film combination. In this experiment, the depth of the γ-ray absorption varies sinusoidally but γ-ray dose variations on the film show an exponentially modulated sine wave. The difference between the blackness made by the genuine sine wave and that by the modulated wave and also the relation between response functions of both cases were investigated by means of Fourier expansion. The result showed about 1.5% and 5% differences in the blackness and the response value respectively. A collimated γ-ray beam was required in the experiment. In order to obtain the collimated beam, slits with narrow width were used. A correction term was found. (auth)

21915 EXAMINING PRESSURE VESSELS WITH RADIOGRAPHY. Bailey, Talmer L. (Combustion Engineering Inc., Chattanooga). Metal Progr., 94: No. 2, 77-8; 80(Aug. 1968).

Welds joining plates up to 26 in. thick were checked with 1 and 2 MeV x-ray machines, cobalt-60 devices, 15 to 25 MeV betatrons, and linear accelerators. It was concluded that there is a need for operators trained in the interpretation of radiographs. (auth)

21916 TESTING ROCKET ENGINE MATERIALS. Hagemmaier, Don (North American Rockwell Corp., Canoga Park, Calif.). Metal Progr., 94: No. 2, 87-8; 90(Aug. 1968).

Radiographic techniques (x-ray machines or radioactive isotopes), liquid penetrants, magnetic particle methods, ultrasonic waves, eddy currents, and heat were used to locate and measure flaws in components. The equipment also helped to find leaks in vessels and tubing and measure the thicknesses of coatings, sheets, plates, and pipe walls. (auth)

21917 QUALITY CONTROL BY NEUTRON TRANSMISSION. Mott, William E.; Rhodes, Donald F. (to Gulf Research and Development Co.). U. S. Patent 3,437,808. Apr. 8, 1969. Filed July 6, 1965.

The presence of a treating material in a workpiece can be determined by a neutron transmission method of quality control. A beam of thermal neutrons is directed at a workpiece and parallel neutrons passing therethrough are detected. A neutron count above a predetermined level causes the workpiece to be rejected. (Offic. Gaz.)

Protective Structures

21918 (AD-675410) CALCULATIONS WITH UNC-SAM-2 OF EXPOSURE RATES MEASURED IN AN OPEN BASEMENT. Buhl, A. R.; Lacetera, Janet E. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). July 1968. 22p. (NDL-TM-44). CFSTI.

A number of experimental studies were conducted to validate theoretical methods of calculating fallout protection afforded by structures. As a part of this program, exposure rates in an open basement were measured. Exposure rates for forty-eight detectors located within the open basement were calculated. These results were obtained using UNC-SAM-2, a Monte Carlo radiation transport digital computer code. The calculated results are compared with experimental measurements and also with comparable adjoint (Monte Carlo) results. (auth) (USGRDR)

Radioactive Material Handling

Refer also to abstracts 21620, 21859, 21871, 23936, 23942, and 24051.

21919 (AAEC/TM-480) DESIGN AND TESTING OF A TYPE B PACKAGING (AUS/S/200) FOR LARGE RADIOACTIVE SOURCES TO THE REQUIREMENTS OF THE INTERNATIONAL ATOMIC ENERGY AGENCY. Nelmes, R. H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1968. 16p. Dep.

An existing type of lead shielded, steel-clad container weighing 6,830 lb (3,105 kg) was fitted with a protective crate and tested in accordance with the I.A.E.A. Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, (1967). The packaging has been approved by the Australian Competent Authority as a Type B packaging for the shipping of large radioactive sources. (auth)

21920 (AD-675426) RADIOACTIVE LIQUID WASTE CONCENTRATION IN A DISPOSABLE CONTAINER. Maloney, Joseph C.; Hill, Charles G. Jr.; Lachapelle, David G.; Tarbox, James L. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). June 1968. 87p. (NDL-TR-107). CFSTI.

A practical semi-fixed facility for the treatment of low-level radioactive liquid waste in which the evaporation vessel, a 55-gallon drum, is the ultimate shipping container was developed. The system eliminates many of the handling, transfer, and maintenance problems associated with other evaporation systems previously evaluated. Average evaporation rates range from 55 to 66 gallons per hour, depending on the solids content in the evaporation vessel. (auth) (USGRDR)

21921 (AECL-3256) FURTHER STUDIES OF DILUTION IN WINNIPEG RIVER NEAR WNRE. Merritt, W. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov. 1968. 5p. Dep. CFSTI. CAN $0.20.

The dilution pattern of the heated effluent in the Whiteshell Nuclear Research Establishment (WNRE) process sewer was compared with that of the unheated effluent previously studied. Results showed an increase in dilution by a factor of about two for the heated effluent within the first 200 meters. Studies with dye addition from a buoy anchored in mid-stream showed that apart from lowering the risk of shore contamination, there would be no advantage in extending the outfall into the middle of the river. (auth)

21922 (CNAEM-61) POLYMER-INCAPSULATION OF ACTIVITIES FROM WASTE SOLUTIONS ON ION-EXCHANGE AND ADSORBENT PARTICLES. Erben, M. Talat; Uenseren, Envare; Yalcin, Ali (Cekmece Nuclear Research Center, Istanbul (Turkey)). Sept. 30, 1968. 33p. Dep.

Encapsulation of radioactive adsorbent and ion exchange particles with polymers was investigated. Methyl acrylate, methyl methacrylate, styrene, acrylonitrile, methacrylonitrile, acrylic acid, and methacrylic acid were used. Copolymers were also studied. The best polymerization temperature is about 60°C with 1% benzoylperoxide as catalyst. Pure polystyrene becomes very brittle after irradiation. Methacrylonitrile polymerizes extremely slowly. Acrylonitrile leads to inhomogeneous products. Acrylic and methacrylic acids produce hydrophilic products which deteriorate when they come into contact with water releasing the encapsulated activity. Methyl acrylate, and methyl methacrylate produce spongeous products which are not suitable for encapsulation. Copolymers of styrene with acrylonitrile, methacrylonitrile, acrylic acid, and methacrylic acid have to be discarded for similar reasons. Styrene-methyl methacrylate copolymers show poor radiation stability. The best system among those studied seems to be styrene-methyl acrylate. Samples covered with this copolymer have good radiation stability and mechanical strength. Tri-n-butylphosphate and di-n-butylphosphate plastifiers improve the quality of the products. Radiation stability tests indicate that polymer encapsulation with styrene-methyl acrylate copolymers is feasible for several millicurie activities per gram. (auth)

21923 (CONF-680821-, pp 312-29) OFF-GAS SYSTEMS FOR NUCLEAR CONTAMINATED COMBUSTIBLES. Gaskins, R. D.; Kazel, W. G. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.).

Incinerator off-gas systems employed at the Dow Chemical Company, Rocky Flats Division, are described. A discussion of wet and dry off-gas equipment and subsequent problems is presented. (auth)

21924 (CONF-680821-, pp 362-7) PREFABRICATED EMERGENCY INCINERATOR FOR RADIOACTIVE WASTES. Bloore, Ernest W. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.).

The feasibility of using a prefabricated incinerator to concentrate contaminated combustible materials from an emergency situation is evaluated. The airborne radiological hazard resulting from the combustion process is analyzed. (auth)

21925 (EUR-3485(Vol.1)) EXAMINATION OF THE INTERNATIONAL ATOMIC ENERGY AGENCY'S REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. TECHNICAL PACKAGING REQUIREMENTS. AN ANALYSIS OF THE CRITERIA AND TESTS, TOGETHER WITH A STUDY OF PRACTICAL MEANS OF COMPLIANCE. Final Report. (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). 1968. 263p. Dep.

Regulations regarding radioactive materials involving criticality hazards and those not involving criticality hazards are explained and summarized. Safety principles depending on external events and on the effects of the material itself on its packaging are outlined. Three nuclear safety classifications are enumerated. Principles of radioactive material shipping and transport are given. The requirements are listed for nuclear safety, dose rates, external contamination levels, activity limitations, pyrophoric materials, and containment and shielding functions. Testing methods for all conditions are discussed. (J.C.W.)

21926 (ORNL-TM-2495) TECHNIQUES AND APPARATUS FOR INSPECTION, HANDLING, AND ANNEALING HIGHLY RADIOACTIVE FUEL MICROSPHERES. Morgan, M. T.; Towns, R. L. (Oak Ridge National Lab., Tenn.). Mar. 1969. Contract W-7405-eng-26. 30p. Dep. CFSTI.

Techniques and equipment have been developed for remote handling, inspecting, and annealing of coated nuclear fuel microspheres. The equipment is adapted for use in shielded glove boxes and includes a revolving microprobe stage with vibrator to turn particles over remotely, a suction pickup, wrist-action manipulators, a Geiger-Mueller tube probe, and induction type annealing furnace, and a separate gas collection and analysis system. (auth)

21927 (PINSTECH/HP-7) ION EXCHANGE PROPERTIES OF PINSTECH SOIL FOR THE DISPOSAL OF LIQUID RADIOACTIVE WASTE DIRECTLY INTO THE GROUND. Aziz, Abdul; Mubarak, M. A. (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Health Physics Div.). 1968. 30p. Dep.

Soil characteristics, e.g., type, ion exchange/adsorption capacity for some radionuclides with and without the presence of competing ions, and leaching of adsorbed ions on the soil by various chemical solutions were investigated. The ion exchange capacity of the soil was found to be between 5 to 7 meq/100 gm soil. The adsorption of radioactive trace ions on the soil was inhibited by the presence of competing ions. The degree of inhibition was more for higher concentration of competing ions and their higher ionic charge. Solutions such as 1 N NH_4Cl and 0.1 N HNO_3 leached away almost all cesium, strontium, and cobalt ions from the soil. Dilute acidic solutions leached the adsorbed ions depending on the H^+ ion concentration in the solution. Characteristics of PINSTECH site, e.g., geography, climate, sub-soil geology, are discussed from the point of view of the safe disposal of liquid radioactive wastes into the ground. It was concluded that the disposal of low level liquid waste at PINSTECH into shallow pits in the ground is an economic and safe method of disposal. It was estimated that a total of about 8.5 million imperial gallons per year of low level liquid waste can be disposed of from a pit measuring 100 ft × 50 ft × 5 ft which would cost only $400. (auth)

21928 MODEL PILLAR TESTS FOR EVALUATING THE STRUCTURAL STABILITY OF OPENINGS IN ROCK SALT UTILIZED FOR THE DISPOSAL OF RADIOACTIVE WASTES. Lomenick, T. F.; Bradshaw, R. L. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 9: 269-78(Feb. 1969).

A promising geologic environment for the disposal of large quantities of heat-generating, high-level, radioactive waste is subterranean rock salt deposits. In order to design an actual disposal facility in salt, it is necessary that the effects of elevated temperature, load, and stratigraphic relations on structural openings be determined. To predict flow in rock salt, scale models of salt pillars and their surrounding rooms have been fabricated from cores taken in mines at Lyons and Hutchinson, Kansas; Retsof, New York; Detroit, Michigan; Grand Saline, Texas; Cote Blanche, Louisiana; and Asse, Germany. Tests have been conducted at temperatures of 22.5, 60, 100, and 200°C for axial loads of 2,000, 4,000, 6,000, 8,000, and 10,000 psi at each temperature. From these tests, it has been observed that the deformation of the pillars increases markedly with increasing loads. However, even more significant is the greatly accelerated creep rates of the salt at elevated temperatures. At all axial loads and constant temperatures, there is initially a high creep rate that decreases with time. Creep rates have been observed to continue to decline even after $3\frac{1}{3}$ years of testing. Laboratory studies show that thin shale beds, which commonly occur with bedded salt deposits, cause greatly accelerated rates of deformation in excavated cavities when they occur in the pillars at the roof and floor interfaces. Under these conditions the shales, which are effective friction reducers, serve to reduce significantly the transfer of lateral confining stresses from the roof and floor of the openings into the pillars. (auth)

21929 MANIPULATOR SOCK (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1863).

3 drawings.

A manipulator boot used with a mechanical master slave manipulator is described. The booting forms the primary barrier between radiation in the alpha enclosure and the manipulator and is fabricated from flexible Krene plastic tube 12 and 20 mils thick. (For details see TID-4100 Suppl. 53). (F.S.)

21930 LLD-1 SHIPPING CONTAINER (Engineering Materials). (Richland Operations Office (AEC), Wash.). (CAPE-1859).

6 drawings.

A shipping container used by Atlantic Richfield Company (ARHCO) for transporting plutonium metal and oxide is described. The outside box is fabricated of 24 gage galvanized steel. Inside the box is a support cage fabricated of pipes. The inner case is fabricated from 5 in. Sch 120 pipe $\frac{3}{8}$ in. thick with felt glued to the outside. (For details see TID-4100 Suppl. 53). (F.S.)

21931 MULTIPLE-ORIENTATION ARM FOR MECHANICAL HANDLING. (to Societe Siersatom). British Patent 1,148,365. Apr. 10, 1969. Priority date July 13, 1966, France.

A mechanical multiple orientation arm is described for remote handling of objects under difficult conditions such as in very high or very low temperature, in a high vacuum, under high pressure, in a radioactive or corrosive atmosphere, under heavy weights, or under the sea. The orientation is variable by hydraulic, pneumatic, electric or electromagnetic actuation methods. The arm consists of a number of similar elements joined so that one element forms an extension of the other by connecting elements allowing the former element to move with at least two degrees of freedom and to pivot with respect to each other independently of the other elements. (F.S.)

Vacuum Engineering

Refer also to abstract 22138.

21932 (RFP-1140) PNEUMATIC HEADGATE VALVE CONTROLLER. Bowdey, R. Donald (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Feb. 26, 1969. Contract AT(29-1)-1106. 5p. Dep. CFSTI.

In vacuum processes requiring partial pressure during experiments, there is a problem of reaching the desired pressure level and maintaining the pressure with an oil-diffusion pumped vacuum system. A novel method of throttling the headgate valve in an oil-diffusion pumped system is described which permits maintaining the partial pressure. (auth)

21933 A VACUUM BREAKTHROUGH ASSEMBLY FOR USE WITH STANDARD REMOTE-HANDLING TONGS. Pugh, A. R.; Pirie, M. A. M. (Berkeley Nuclear Labs., Eng.). J. Phys., E (London), 2: 434-5(May 1969).

An adaptation is described of standard remote-handling tongs

to enable manipulations to be performed in a high vacuum or high purity environment. A variety of operations is possible using commercially available tong attachments or by modifications to an existing attachment. The tong assembly described was used successfully in a vacuum of better than 10 μtorr over the full range of 15 inch axial movement and 40° solid angle deflection. If necessary, the maximum axial and angular movements can be increased by appropriate design modifications. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 23746.

General Detectors and Monitors

Refer also to abstracts 21621, 22148, 23849–23856, 23881, 23882, 24036, and 24037.

21934 (AD–675501) HIGH-LEVEL PASSIVE RADIATION MONITOR: THE SOLID COMPTON RECOIL ELECTRON DETECTOR. Final Report. Murphy, Preston V. (Thermo Electron Corp., Waltham, Mass.). Sept. 1968. Contract N00228-67-C-2095. 71p. (TE–4079-179-68; USNRDL-TRC–68-43). CFSTI.

Studies were carried out on a high level passive radiation monitoring system based on charge generation from electron scattering in a dielectric-electrode matrix. The radiation detecting element is called the Solid Compton Recoil Electron Detector (SCRED). The physical principles of detector operation are defined, and the results of experimental studies on charge transport are described. A number of detectors of different materials, sizes, and shapes were assembled and evaluated during the course of the program. (auth)(USGRDR)

21935 (CONF-680821–, pp 228-34) TRITIUM AIR MONITOR. Moghissi, A. A.; Kelley, H. L.; Phillips, C. R. (Southeastern Radiological Health Lab., Montgomery, Ala.).

A tritium monitor based on scintillation is described. A block diagram of the monitor and a schematic diagram of the detection chamber are presented. General design specifications are included. (D.C.C.)

21936 (FRL–3) GROSS BETA COUNTING OF ENVIRONMENTAL MATERIALS. Dutton, J. W. R. (Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Fisheries Radiobiological Lab.). Oct. 1968. 13p. Dep.

Two methods for measuring the beta activity in environmental samples are described and evaluated. The infinite depth technique employs a sample source designed to appear of infinite depth, in terms of beta emission, to an end-window G-M detector. The thin source technique uses an end-window proportional counter. A potassium chloride standard is used. Sample preparation techniques are described. (W.H.K.)

21937 (NYO–3086-8, pp VI.1-26) DEVELOPMENT OF AN INTEGRATING RADON DETECTOR FOR PERSONNEL OR AREA MONITORING. Ribeiro, Carlos Costa; Thomas, James; Drew, Robert T.; Wrenn, McDonald E.; Eisenbud, Merril (New York Univ., N. Y. Inst. of Environmental Medicine).

Positively-charged polonium-218 from the decay of radon-222 is collected electrostatically and counted with a scintillation detector with a photographic recording system. The detector system is described, and its efficiency and calibration are discussed. The detector can be used as a personnel or area monitor. (W.H.K.)

21938 (NYO–3408-33) THE SCINTILLATION PROCESS IN INORGANIC PHOSPHORUS. Annual Progress Report. Van Sciver, Wesley J. (Lehigh Univ., Bethlehem, Pa.). Mar. 25, 1969. Contract AT(30-1)-3408. 14p. Dep. CFSTI.

The experimental program in 1968 included studies of properties of exciton states in NaI, thermodynamic defect structure of NaI and other alkali halides (Q center), influence of divalent cations on the quench production of Q centers, intrinsic and direct-related photoconductivity in NaI and a search for a high density scintillator. (B.G.D.)

21939 (ORNL-TM–2323) SYNTHESIS OF A DIRECTLY-COUPLED, WIDEBAND, DELAY-LINE BRIDGE WITH HIGH GAIN-STABILITY. Paulus, Thomas Joseph (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 145p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The design criteria, network configuration and amplifiers required in a directly-coupled, wideband, delay-line bridge for pulse shaping are presented. High gain-stability is achieved by minimizing gain variations in the amplifiers due to variations in amplifier current gain and input and output impedance. Wideband operation is achieved by choosing the amplifier configuration which best maintains a large loop gain in high frequency. Three compensation techniques are discussed and incorporated into the amplifiers. Experimental results are presented for the inverter and adder amplifier individually and in cascade, and for the delay-line bridge as a unit. The forward path of both the inverter and adder amplifiers contains four transistors with four additional transistors used in the bias circuit. Each amplifier has a common base input stage, two emitter follower interstages, and a common emitter output stage. The emitter followers are separated by a bridged-T compensator. The delay line has a characteristic impedance of 93Ω. The inverter amplifier has a 90 db loop gain, 0.5 voltage gain (terminated), 0.9 nsec rise time, 20% overshoot, and 20% feedthrough when tested with a 50Ω source impedance. The added amplifier has an 80 db loop gain, 5.8 voltage gain (terminated), 2.3 nsec rise time, 15% overshoot, and no feedthrough when tested with a 50Ω source impedance. The adder amplifier can be adjusted to give no overshoot with 3.1 nsec rise time. The delay-line bridge has a 0.5 voltage gain (terminated), 2.3 nsec rise time, 15% overshoot, and 5% feedthrough when tested with a 93Ω source impedance. The output pulse can be adjusted to return exactly to the base line. (auth)

21940 (ORNL-TM–2463) DESCRIPTION OF PROCESS RADIATION MONITORING INSTRUMENTATION IN THE THORIUM-URANIUM RECYCLE FACILITY, BUILDING 7930. Hall, C. C.; Knowles, D. J. (Oak Ridge National Lab., Tenn.). Jan. 14, 1969. 15p. Dep. CFSTI.

Radiation monitoring instrumentation, installed in the Thorium-Uranium Recycle Facility, Building 7930, to continuously monitor process areas, equipment, and waste (gaseous and liquid) as it is discharged from the facility is described. A duct carrying cell ventilation air is monitored before the ventilation air reaches the HFIR stack. A drain line carrying liquid waste discharged from the facility is monitored before the liquid waste reaches the holding pond area. A recirculating water line is monitored to detect radioactivity in the recirculating water system. Background monitors are installed on the cell walls in the operating area to detect an increase in beta-gamma radiation and to warn operating personnel if the level becomes excessive. (auth)

21941 (SZS–15/68) TRENDS IN THE DEVELOPMENT OF WHOLE-BODY COUNTING TECHNIQUES AND THE DESIGN OF WHOLE-BODY COUNTERS. Poulheim, K.-F.; Loessner, V. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Aug. 1968. 13p. (In German). Dep.

A brief summary is given of the use of whole-body counters in the fields of radiation protection and nuclear medicine today and in the future. It is suggested to classify the various types of whole-body counters into four groups according to their special application. This classification is helpful for the planning of whole-body counters as well as the suitable use of existing whole-body counters. It is briefly referred to the present possibilities of whole-body counting in the G. D. R. (auth)

21942 (SZS–16/68) MOVABLE FLOORING CONTAMINATION MONITOR. Jaeckel, P.; Henning, H.; Runge, M. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Nov. 1968. 34p. (In German). Dep.

A manageable practicable flooring contamination monitor is described which contains five large-area counters for β-radiation of the Soviet type C5T-10. In connection with the commercially available counting-rate meter VA-J-105 the monitor is immediately ready for application without other accessories. The coupling between counters and electronic input circuit is made by the electromagnetic radiation field of the counters. Thereby a big number of electronic parts is abolished. The calibration is made by different ^{137}Cs-sources. (auth)

21943 (UCRL–18705) SCINTILLATION CAMERA AND MULTIPLANE TOMOGRAPHIC SCANNER. Anger, H. O. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1969. Contract W-7405-eng-48. 45p. (CONF-681123–1). Dep. CFSTI.

From Japanese Society of Nuclear Medicine Meeting, Okayama, Japan.

The design and operation of the gamma-ray scintillation camera, the positron camera, and the multiplane tomographic scanner are described. The multiplane tomographic scanner combines radioisotope camera principles with rectilinear scanning to achieve high sensitivity and high resolution over a wide range of depths in the subject. Several scintigrams are produced from a single scan of the subject, each scintigram being focused at a different depth. (W.H.K.)

21944 (UJV–2113-F) LINEAR POLARIZATION MEASUREMENTS BY Ge(Li) DETECTOR. Honzatko, J.; Kajfosz, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Dec. 1968. 20p. Dep.

A thin planar Ge(Li) detector was used as a coincidenceless polarimeter for measuring linear polarization of cascade gamma quanta. The results of the measurement with ^{60}Co are presented and compared with the theoretical curves of the polarization sensitivity obtained by analytical calculations and by the Monte Carlo method. (auth)

21945 AN INVESTIGATION OF SYSTEMATIC ERRORS IN TIME DIFFERENTIAL ANGULAR CORRELATION MEASUREMENTS PERFORMED WITH A 4-DETECTOR-APPARATUS. Wagner, H. F.; Forker, M. (Univ., Bonn). Nucl. Instrum. Methods, 69: 197-208(Apr. 1969).

A 4-detector-apparatus for differential $\gamma\gamma$-angular correlation measurements is described. Systematic errors in such measurements, which arise from a slightly angular dependent detector environment are investigated and discussed. In most cases these errors can be detected only by a multi detector arrangement; therefore differential angular correlation measurements performed with a 2-detector-apparatus can very easily yield incorrect results. (auth)

21946 TOTAL ENCLOSING ACTIVE CHARGE PARTICLE SHIELD. St. Onge, R. N.; Lockwood, J. A. (Univ. of New Hampshire, Durham). Nucl. Instrum. Methods, 69: 347-9 (Apr. 1969).

The 4π hollow scintillator shield uses two curved-cathode photomultipliers. By utilizing both total internal and spectral reflection and having the shield thickness compensatingly greater at larger distances from the phototubes, considerable improvement in light collection is realized. (auth)

21947 EXPERIMENTAL PEAK/TOTAL RATIOS FOR A FEW NaI(Tl) CRYSTAL SIZES. Mishra, U. C.; Sadasivan, S. (Bhabha Atomic Research Centre, Bombay). Nucl. Instrum. Methods. 69: 330-4(Apr. 1969).

The ratios of full energy peak/total counts (peak/total ratios) for five different sizes of NaI(Tl) crystals were experimentally determined for point sources. A brief description of the experimental set up and estimation method is given. The results are compared with theoretical and experimental values reported by others, where available. The usefulness of the data is discussed. The sources of error and their implications are also included. (auth)

21948 TELESCOPE FOR GAMMA-RAY ASTRONOMY. Niel, M. (CNRS, Toulouse. Centre d'Etude Spatiale des Rayonnements, Toulouse); Cassignol, M.; Vedrenne, G.; Bouigue, R. Nucl. Instrum. Methods, 69: 309-15(Apr. 1969).

A telescope using spark chamber techniques is described for detecting high energy γ-rays. The area solid angle factor is 160 cm$^2\cdot$ sr and the conversion efficiency for a 100 MeV γ-ray is 17%. Events are recorded photographically. An orienting system counteracts the rotation of balloon about the zenith to within $\pm\frac{1}{2}°$. The limit sensitivity which can be reached is 2.6×10^{-6} γ/cm$^2\cdot$sec in the energy range 100 MeV to 1 GeV. The system has operated successfully on two flights. (auth)

21949 DESIGN OF A SIMPLE MOESSBAUER RESONANCE COUNTER. Fenger, J. (Research Establishment Risoe, Roskilde, Denmark). Nucl. Instrum. Methods, 69: 268-70(Apr. 1969).

A simple resonance counter for source studies on ^{57}Fe is described. Its performance is compared with that of a scintillation detector and its advantages are pointed out. (auth)

21950 TIME MEASUREMENTS WITH Ge(Li) DETECTORS. Brandenberger, J. D. (Univ. of Kentucky, Lexington). Nucl. Instrum. Methods, 69: 271-6(Apr. 1969).

A method of obtaining improved time resolution from coincidence measurements utilizing large volume Ge(Li) detectors is presented. The analysis indicates that a time resolution of the order of 1 ns is obtainable if a preamplifier with a short rise time is used. An experimental time resolution of 3.8 ns is obtained using a preamplifier with a rise time considerably longer than the charge collection time constant of a Ge(Li) detector. These results all apply to detection of gamma rays having a large range of energies detected with a large volume coaxial detector. (auth)

21951 CHARACTERISTICS OF ELECTRON MULTIPLIERS USED AS DETECTORS FOR LOW ENERGY PROTONS. Tatry, B.; Bosqued, J. M.; Reme, H. (CNRS, Toulouse. Centre d' Etude Spatiale des Rayonnements, Toulouse). Nucl. Instrum. Methods, 69: 254-60(Apr. 1969).

Windowless electron multipliers present a detection efficiency close to 90% for protons and for He$^+$ ions above 2 keV. The proper polarization of the entrance of the detector enables one to preserve this efficiency with much lower energies. These detectors do not allow for direct spectrometry; it is necessary to join to them an electrostatic analyzer. This type of analysis has been experimentally and theoretically developed for the study of the spectrum and of the angular distribution of auroral protons from 100 eV to 40 keV. (auth)

21952 A SEVEN-DETECTOR SYSTEM FOR $\gamma-\gamma$ ANGULAR CORRELATIONS. Larsen, J. T.; Schick, W. C. Jr.; Talbert, W. L. Jr.; Haddad, D. I. (Ames Lab., Iowa). Nucl. Instrum. Methods, 69: 229-39(Apr. 1969).

A system of seven NaI(Tl) detectors in a fixed configuration has been constructed for the study of $\gamma-\gamma$ angular correlations of short-lived fission product activities. Coincidence events between any two detectors are inspected to determine the angle between the detectors and the presence of a gating transition signal in one detector. The gated spectrum of the other detector is recorded as a function of angle in a large-memory multichannel analyzer. Analysis of the resulting spectra gives values for the angular correlation coefficients A_2 and A_4. A modification to the system allows the use of one Ge(Li) detector for decays requiring high resolution. The performance of the system is discussed for transitions in the decays of ^{60}Co and ^{152}Eu. (auth)

21953 RESPONSE OF SILICON DETECTORS TO MONOENERGETIC ELECTRONS WITH ENERGIES BETWEEN 0.15 AND 5.0 MeV. Berger, M. J.; Seltzer, S. M.; Chappell, S. E.; Humpreys, J. C.; Motz, J. W. (National Bureau of Standards, Washington, D. C.). Nucl. Instrum. Methods, 69: 181-93(Apr. 1969).

By means of measurements as well as Monte Carlo calculations response functions have been obtained which describe the pulse-height distributions produced by monoenergetic electrons incident perpendicularly on silicon detectors. Generally good agreement has been found between experimental and Monte Carlo results at energies of 0.25, 0.50, 0.75, and 1.00 MeV for detectors with thicknesses of 0.061, 0.105, 0.191, 0.530, 1.0, and 3.0 mm. Additional calculated results have been obtained as follows: response functions at fifteen energies between 0.15 and 5.0 MeV for detectors with ten thicknesses between 0.05 and 10.0 mm; response functions for arrangements in which the silicon detector is shielded partially or completely by other detectors operating in anticoincidence; and reflection, transmission and absorption coefficients of electrons for plane-parallel silicon targets. (auth)

21954 DETECTION OF LOW-INTENSITY ALPHA DECAY BRANCHES WITH SEMICONDUCTOR DETECTORS. Klein, S. S.; Knapen, M. (Technische Hogeschool, Eindhoven, Netherlands). Nucl. Instrum. Methods, 69: 194-6(Apr. 1969).

The detection limit for low-intensity α-transitions with semiconductor detectors may be lowered to 10^{-4}% of the total transition rate, using particle identification methods which are discussed. (auth)

21955 AN IMPROVED METHOD FOR THE LIQUID SCINTILLATION COUNTING OF $^{14}CO_2$. Lin, Tz-hong; Pohlit, Helmut (Univ. of California, Berkeley). Anal. Biochem., 28: 150-5(Apr. 4, 1969).

A method was described which permits the determination of the specific activity of $^{14}CO_2$ with an accuracy limited only by the accuracy of the liquid scintillation counter. Its principal idea is the selective conversion of CO_2 to nonvolatile organic compounds, such as benzoic acid. While this method is applicable quite generally it has been applied with particular success in connection with the Schmidt degradation of samples as small as 0.2 mmole where contamination of the evolved CO_2 is serious due to the necessarily large excess of reactants. (auth)

21956 AN EFFICIENT AND ACCURATE METHOD OF MEASURING SMALL AMOUNTS OF β-EMITTERS FROM A METAL PLATE WITH A WINDOWLESS GAS FLOW DETECTOR. Sokkanen, R.; Saure, A.; Pesonen, S. (Univ. of Helsinki). Atompraxis, 15: 42-3(Jan.-Feb. 1969).

A method is described by which β emitters are measured in dry state from a metallic sample plate with complete 2π geometry and a windowless gas-flow detector (Berthold). The efficiencies for ^{3}H, ^{14}C, and ^{35}S were 43%, 65%, and 75% respectively. The high efficiencies obtained are partly due to the back-scattering of β particles. A comparison with liquid scintillation counting is made. (auth)

21957 PRECISION-PULSE-GENERATOR FOR THE SIMULATION OF RADIATION-DETECTOR-PULSES. Attwenger, W.; Gruber, G.; Patzelt, R. (Reaktorzentrum, Seibersdorf, Austria). Nucl. Instrum. Methods, 70: 103-5(Apr. 1, 1969).

To reach the highest precision (linearity and stability) of the pulse-amplitude, the pulse-generator must be designed with a minimum of active components. Normally a mercury-wetted relay is used together with an R-C-combination as pulse shaping network. If a transistor is used as switch, a repetition rate up to 10,000 pulses/sec can be obtained. The time-jitter between control-signal and output-pulse is avoided, which is inherent when a relay is used. A modified design of the pulse shaper allows to use the transistor with the emitter grounded. The stability of the output-amplitude depends principally on the collector-emitter saturation-voltage U_{CES}. The dependence of U_{CES} on I_B, I_C and temperature T has been investigated. The output-amplitude is stable within 10^{-4}, the linearity is better than 10^{-3} of full scale. (auth)

21958 AN IMPROVED METHOD FOR AUTOMATIC COMPENSATION OF DEADTIME LOSSES. Seda, J. (Univ., Prague). Nucl. Instrum. Methods, 70: 121-2(Apr. 1, 1969).

An improved method for automatic compensation of deadtime losses is described. A comparison of the improved method with two other methods of compensation, including the considerations of exactness of the methods, is presented. (auth)

21959 SUMMING EFFECT CORRECTION OF CORRELATION COEFFICIENTS. Milanovic, J. V.; Kukoc, A. H.; Krmpotic, D. M. (Boris Kidric Inst., Belgrade). Nucl. Instrum. Methods, 70: 90-2(Apr. 1, 1969).

The admixture of a three gamma-quanta correlation into the two gamma-quanta directional correlation due to summing of two gamma-quanta in an NaI detector has been calculated. General formulas for the correction of the correlation coefficients are presented. (auth)

21960 HEATABLE COUNTER WITH TWISTED ANODE. Eckey, H. (Univ., Muenster, Ger.). Nucl. Instrum. Methods, 70: 107-8(Apr. 1, 1969). (In German).

A simple Geiger-Müller counter is described which allows the detection of soft α-, β- and γ-radiation. The counter is heatable up to 180°C and suitable for the measurement of exoelectron-glowcurves. (auth)

21961 GERMANIUM X-RAY ESCAPE PEAKS IN THE 40 TO 411 keV RANGE PRODUCED BY SMALL WINDOWLESS Ge(Li) DETECTORS. Ungrin, J.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods, 70: 112-14(Apr. 1, 1969).

Germanium x-ray escape peaks have been observed for gamma rays in the energy range 40 to 411 keV by using a small windowless Ge(Li) detector 3 mm thick. The ratio of the area of the escape peak to that of the photo-peak is ≈0.24% and almost independent of gamma ray energy for energies above ≈150 keV. (auth)

21962 PARTICLE IDENTIFICATION UTILIZING AN ON-LINE COMPUTER. Armstrong, D. D.; Beery, J. G.; Flynn, E. R.; Hall, W. S.; Keaton, P. W. Jr., Kellogg, M. P. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods, 70: 69-76(Apr. 1, 1969).

An on-line computer program is described which accepts pulses from a ΔE-E solid-state detector pair to provide particle-identification. Applications and comparisons with other systems are discussed. (auth)

21963 WHITE MOUNTAIN COSMIC RAY NEUTRON MULTIPLICITY MONITOR. Nobles, R. A.; Alber, R. A.; Newkirk, L. L.; Walt, M.; Wolfson, C. J. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Nucl. Instrum. Methods, 70: 45-51(Apr. 1,1969).

The multiplicity, i.e., the number of neutrons produced by a single nucleon incident upon a neutron monitor, increases, on the average, with increasing nucleon energy. A new type neutron monitor which was especially designed to study the cosmic radiation by taking maximum advantage of this multiplicity effect is described. The neutron multiplicity monitor has a Bi target of increased thickness and a graphite moderator, instead of the customary Pb target and paraffin (or polyethylene) moderator of other monitors. A transistorized data-handling system records multiplicities from 1 to 399 and provides hourly readouts of the data onto magnetic tape. The procedure used to correct the data for the accidental overlapping of multiplicities is described together with the monitor's neutron background, detection efficiency, mean life time and counting statistics. A description of the White Mountain cosmic ray neutron multiplicity monitor station is included. (auth)

21964 COUNTING STATISTICS OF NUCLEAR DETECTORS. Foglio Para, A.; Mandelli, Betton M. (CESNEF, Milan). Nucl. Instrum. Methods, 70: 52-6(Apr. 1, 1969).

The behavior of paralyzable and non-paralyzable detectors, affected by a dead time τ, is analyzed in different conditions of counting. Exact or approximate formulae for calculating the probability distributions are developed and from these the mean values κ and the variances σ^2 are inferred. Indicative graphs are reported, showing the distortion of the Poisson distribution of the incoming particles. (auth)

21965 LOW ENERGY RADIATION DETECTION WITH SILICON SEMICONDUCTOR DETECTORS USING A NEW TYPE PREAMPLIFIER. Desi, S. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1746. Nucl. Instrum. Methods, 70: 57-60 (Apr. 1, 1969).

A low noise preamplifier utilizing a temperature controlled FET input stage is described. In conjunction with a lithium drifted silicon detector, the amplification system makes possible measurements of low energy nuclear radiation with high resolution. Experimental data are presented which show that a resolution of 355 eV (fwhm) can be obtained for x-rays of about 6 keV. The Fano-factor (statistical "smoothing" factor) for silicon has been determined as $F = 0.29 \pm 0.04$. (auth)

21966 STOPPING POWER OF GERMANIUM FOR PROTONS BETWEEN 0.35 AND 5.5 MeV. Gorodetzky, S.; Pape, A.; Cooperman, E. L.; Chevallier, A.; Sens, J. C.; Armbruster, R. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods, 70: 11-12(Apr. 1, 1969). (In French).

The proton stopping powers of Ge have been measured for numerous energies between 0.35 and 5.50 MeV. Experimental and corrected values are presented as well as some calculated range values. (auth)

21967 AN IMPROVED LIQUID HYDROGEN DIFFERENTIAL CHERENKOV COUNTER. Ayres, D. S. (Univ. of California, Berkeley); Cormack, A. M.; Greenberg, A. J.; Kenney, R. W.; McLaughlin, E. F.; Schafer, R. V.; Caldwell, D. O.; Elings, V. B.; Hesse, W. P.; Morrison, R. J. Nucl. Instrum. Methods, 70: 13-19(Apr. 1, 1969).

A liquid hydrogen differential Cherenkov counter was developed to detect 0.3-GeV/c ($\beta = 0.92$) pions for comparing π^+ and π^- lifetimes in a check of CPT invariance. This type of counter, previously reported, has now been improved considerably so that it gives no counts when empty, remains clean with no window fogging, and has a very stable index of refraction. Two similar counters were constructed with 4- and 7-in.-dia apertures, and both could be used with either liquid hydrogen or liquid deuterium as the radiating medium. Each counter cleanly separated pions and muons of the same momentum, with a rejection of better than 10^4. (auth)

21968 A STUDY OF THE USE OF LIGHT SHIFTING SUBSTANCES IN CHERENKOV RADIATORS APPLICATION TO A K^+ COUNTER. Cosme, G.; Jullian, S.; Lefrancois, J. (Ecole Normale Superieure, Orsay, France). Nucl. Instrum. Methods, 70: 20-4(Apr. 1, 1969).

The use of light shifting substances dissolved in a liquid Cherenkov counter has been studied. It was found that POPOP was the most suitable of the shifters studied. Ethylene glycol and bromobenzene were found to be good solvents. The light gain when using a shifter was approximately 2.5. A counter based on these properties was used to detect the decay products of K^+ mesons. (auth)

21969 APPLICATION OF THE THEORY OF RELIABILITY TO NUCLEAR INSTRUMENTATION. Bevilacqua, S. (CNEN-CSN, Casaccia, Italy); de Agostino, E.; Rispoli, B. Com. Naz. Energ. Nucl., Notiz., 15: No. 2, 43-52(Feb. 1969). (In Italian).

After reviewing the principles of the theory of reliability and its most important developments, an example of the application of such theory to nuclear instrumentation is discussed. The results of a study on the design stage and the reliability of an electronic system are presented and compared with the experimental data recorded during the operation of the system. (auth)

21970 DETECTION OF NUCLEAR RADIATION. Fioroni, Furio (CSN, Casaccia, Italy). Com. Naz. Energ. Nucl., Notiz., 15: No. 2, 31-42(Feb. 1969). (In Italian).

In the field of radiation detection, new methods and whole new classes of detectors have recently been introduced in addition to the methods and designs already in use. The resulting progress in nuclear physics and applications has been noteworthy. Certain aspects of this evolution, with particular regard to the work done at the Electronics Laboratory of the Casaccia Nuclear Research Center are presented. In particular, the illustrations relate to recent work done at this lab. (auth)

21971 PORTABLE RADIATION AND LIGHT DETECTOR USING A p-i-n SILICON DIODE. Bloch, Peter; Worrilow, Charles S. (Univ. of Pennsylvania, Philadelphia). Phys. Med. Biol., 14: 277-81(Apr. 1969).

A portable survey instrument using a silicon p-i-n diode as the radiation detector was designed. It can be used to measure exposure rates in the range 50 mR/hr to 10 R/min, or exposures between 1 mR and 10 R. The radiation waveform can be visualized by attaching an oscilloscope to the output of the instrument. The response per roentgen of the instrument shows a variation of ±8%

in the HVT range from 2 to 8 mm Al. When used as a detector of optical radiation, in conjunction with a Wratten No. 102 filter, the spectral response closely matches the Standard C.I.E. luminosity curve. The instrument can, therefore, also be used to measure the luminance of fluoroscopic screens to determine the conversion efficiency of conventional fluoroscopes as well as image intensified fluoroscopes. (auth)

21972 RECOMBINATION IN IONIZATION CHAMBERS IRRADIATED WITH PULSED ELECTRON BEAMS. I. PLANE PARALLEL PLATE CHAMBER. Ellis, R. E.; Read, L. R. (St. Bartholomew's Hospital, London). Phys. Med. Biol., 14: 293-304(Apr. 1969).

The effects of recombination in a plane parallel plate ionization chamber, when irradiated with pulsed electron beams from about 1 to 50 esu cm^{-3} per pulse, were studied. The plate separation was 1 mm and polarizing voltages from 12 to 1200 V were applied; the results were compared with the theory of J. W. Boag. Large deviations from this theory were found at the higher electron fluence rates, which were explained assuming that charge conduction was due to both ions and to free electrons. Agreement with Boag was obtained for all polarizing voltages when the initial charge density rates were less than 5 esu cm^{-3} per pulse. (auth)

21973 SEMICONDUCTOR DIODE MATRIX FOR ISOTOPE LOCALIZATION. Detko, John (Sloan-Kettering Inst. for Cancer Research, New York). Phys. Med. Biol., 14: 245-53(Apr. 1969).

A semiconductor matrix was developed using lithium-drifted diodes, and successfully applied to two-dimensional radiation localization. It is based on the construction of an array of individual detection regions upon a single silicon diode by orthogonal partitioning of the p and n regions. In the matrix formation parallel grooves, 0.5 mm wide, were cut into both the p and n faces of a silicon diode, penetrating the intrinsic region. The measured resistance achieved across all grooves was at least 10^{9} ohms, as a result of chemical etching and surface treatment. The isolation of the electrode regions bounded by the grooves on the p and n sides of the device permits row and column addressing of charge pulses from ionizing radiations. By interconnecting the rows and interconnecting the columns of a number of such units larger areas can be monitored. A resolution of (3 × 3) mm was achieved. The configuration is considered suitable for the construction of a gamma camera. Construction details and operational characteristics are presented. (auth)

21974 DESIGN OF COLLIMATORS FOR RADIOISOTOPE SCANNING. Husak, V.; Perinova, V. (Palacky Univ., Olomouc, Czech.). Phys. Med. Biol., 14: 233-4(Apr. 1969).

An approach is made to the theoretical design of multichannel focusing collimators based on the expression of Rotenberg and Johns for the minimum path length through the septa. Precise formulae for the number of holes and the efficiency of collimators with circular holes arranged in concentric rings are derived. A comparison is made with the results of the modified Beck theory. Calculations are extended to the case of multichannel collimators with holes of a segmented shape. Five such collimators were fabricated, and their efficiency, calculated from their dimensions, agrees fairly well with experimental results. The relationship between the radius of the field of view and the experimentally-determined point source resolution is discussed. (auth)

21975 PROBLEMS IN THE PRODUCTION OF RADIOACTIVE STANDARD AND MEASURING SOURCES. Schindler, G.; Koch, H. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Isotopenpraxis, 4: 470-2(Dec. 1968). (In German).

Problems in the production of radioactive standard and measuring sources as well as methods and production techniques are reported on. (auth)

21976 AURAL RESPONSE TRANSDUCER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1844). 7 drawings.

An audible (tweeter) indicator is described which is used to replace head phones on portable radiation survey instruments. The unit is plugged into the head phone jack on the survey instrument. It is packaged in a small rectangular case and contains a miniature hearing-aid speaker with a resonant column, a mercury battery, and a gating circuit. (For details see TID-4100 Suppl. 52.) (F.S.)

21977 LIQUID SCINTILLATION COUNTING: DETERMINATION OF BACKGROUND COUNTS OF QUENCHED SAMPLES USING AN EXTERNAL STANDARD CHANNELS RATIO. Takahashi, I. T.; Blanchard, F. A. (Dow Chemical Co., Midland, Mich.). Anal. Biochem., 29: 154-63(Apr. 11, 1969).

A Cs-137, 2 mCi, external standard was used to study the effects of quenching and sample volume on background counts. Background calibration curves in which the external standard ratio is plotted against the background counts were prepared for methyl red, a color quenching agent, and chloroform, a chemical quenching agent. Using these curves, the background counts of some quenched test samples were estimated to within 5% of the actual background. The reproducibility of the external standard ratios and of the background counts of replicate quenched and unquenched samples, and empty vials, was determined. The standard deviation for the external source ratio was smaller than ±1.0% and for the background counts smaller than 5.0%. (auth)

21978 STUDY OF ENERGY TRANSFER IN LIQUID MEDIUM WITH THE AID OF SCINTILLATION COUNTING. Cosandey, Maurice; Lerch, Pierre (Univ., Lausanne, Switzerland). Helv. Chim. Acta, 50: 2215-22(1967). (In French).

The scintillation quenching effect was studied in toluene for numerous compounds. The quenching power of most aliphatic compounds was small, and could be interpreted on the basis of a collision theory. The ketones, and generally all compounds with a high extinction coefficient for toluene fluorescence, has such a high quenching effect that it appeared to be due to a resonance transfer. If the value for the average molecular radius was replaced by ½ the Foerster critical resonance distance, and if a coefficient of migration of energy was added to the diffusion constant, the experimental data fitted the theory exactly. The transfer was more or less reversible. For compounds which are deexcited by a π-π^* transition, it was completely reversible, and quenching was zero. When the excitation energy was degraded by an n-π^* transition, the transfer was completely irreversible and quenching was maximum. For intermediate cases the quenching effect was interpreted with the supplementary hypothesis of an intramolecular energy transfer. (BBB)

21979 PROBLEMS OF HIGH-ENERGY GAMMA-RAY AND PARTICLE DETECTION. Hofstadter, R. (Stanford Univ., Calif.). pp 784-90 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The possibilities of using semiconductor detectors for the detection of high-energy γ rays and elementary particles are discussed. Some preliminary work with 200 and 500 MeV γ rays and 1 to 10 GeV muons is described. (J.W.R.)

21980 THE ENERGY RESOLUTION CAPABILITIES OF SEMICONDUCTOR DETECTORS FOR PARTICLES IN THE 10- TO 100-MeV RANGE. Goulding, F. S.; Landis, D. A.; Pehl, R. H. (Univ. of California, Berkeley). pp 744-56 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Various factors which affect the energy resolution of Si(Li) detectors for 10- to 100-MeV particles are discussed with a view toward estimating the ultimate performance of these detectors. Some of the factors discussed are detector noise, amplifier noise, gain stability, nuclear collisions, trapping effects, background gamma pileup, and detector temperature variations. (J.W.R.)

21981 RECENT ADVANCES IN PARTICLE IDENTIFIERS AT BERKELEY. Goulding, F. S.; Landis, D. A. (Univ. of California, Berkeley). pp 757-66 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Recent advances made at Berkley in techniques of particle identification using semiconductor detectors are summarized. The performance of particle identifiers is discussed. (J.W.R.)

21982 USER'S VIEW. Donovan, P. F. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 772-9 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The performance and capabilities of Ge(Li) detectors for charged-particle and gamma spectroscopy are discussed from a user's point of view. (J.W.R.)

21983 ANALYSIS OF THE BALLISTIC DEFICIT IN SOLID-STATE DETECTOR SYSTEMS. Roddick, R. G. (Argonne National Lab., Ill.). pp 703-7 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A simple method for analyzing effects due to variations in detector pulse shapes and rise times is presented. It is shown that rise-time fluctuations resulting from gain changes can have effects that are comparable with those produced by gain alone. (J.W.R.)

21984 HIGHLY STABLE BIASED AMPLIFIER AND STRETCHER SYSTEM. Roddick, R. G. (Argonne National Lab., Ill.). pp 708-15 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A biased amplifier and stretcher system was designed with special attention given to minimizing thermal effects and compensating for repetition rate effects without degradation in the noise characteristics of the signal. The performance of the system was very good. (J.W.R.)

21985 MEASUREMENT OF AMPLIFIER NONLINEARITY AND GAIN STABILITY WITH MERCURY-RELAY PULSE GENERATORS. Fairstein, E. (Tennelec Instrument Co., Inc., Oak Ridge, Tenn.). pp 716-30 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The use of the bridge technique with mercury-relay pulse generators for measuring amplifier nonlinearity is discussed. Those facets of mercury-relay pulse generator design and application that give rise to noise, drift, and spectral line broadening are examined. (J.W.R.)

21986 A SOURCE OF 3.85-MeV GAMMA RAYS FOR TESTING GERMANIUM(LITHIUM) DETECTORS. Litherland, A. E.; Alexander, T. K.; Jeffs, A. T. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). pp 684-7 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A source of monoenergetic 3.85-MeV γ rays, and lower-energy γ rays, was produced by using $^{10}B(\alpha,p\gamma)^{13}C$ reactions occurring in an intimate mixture of ^{10}B and PuO_2. The reaction as a Q-value of 4.07 MeV, and the first three excited states at 3.09, 3.68, and 3.85 MeV in ^{13}C are populated. The 3.85-MeV level decays to the ground state giving rise to a 3.85-MeV γ ray. This γ ray is suitable for testing Ge(Li) detectors. (J.W.R.)

21987 SIGNAL-TO-NOISE RATIOS OF GATED FILTERS FOR NUCLEAR PULSE AMPLIFIERS. Nowlin, C. H.; Blalock, T. V. (Oak Ridge National Lab., Tenn.). pp 570-89 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

An equation was derived which describes the time-variant mean-square output noise of a linear filter whose input signal is amplitude-modulated stationary random noise. This equation was used to derive simple expressions for cases where the modulator is a linear gate and where the input noise spectral density is constant, where it is inversely proportional to ω^2, and where it is directly proportional to ω^2. Experiments were performed to check the validity of the expressions and good agreement was found. (J.W.R.)

21988 NOISE THEORY FOR PULSE AMPLIFIERS USING TIME DOMAIN ANALYSIS AND CORRELATION TECHNIQUES. Amsel, G. (Ecole Normale Superieure, Orsay, France.). pp 590-602 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Transient response concepts were used to formulate a theory allowing the calculation and measurement of the properties of noise in amplifier systems for semiconductor detectors. Time domain analysis is used on the theoretical level, and the sampling oscilloscope is used for practical measurements. (J.W.R.)

21989 STATISTICAL ANALYSIS OF FAST FLUCTUATING SIGNALS USING SAMPLING TECHNIQUES. Bosshard, R. (Ecole Normale Superieure, Orsay, France). pp 603-19 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Two systems for the statistical analysis of fast fluctuating signals are described. The first system, comprising a sampling scope and a multichannel analyzer, takes the ensemble average of sampled signals as a function of time. The second system, which uses a two-dimensional analyzer and the elements of the first system, gives a complete picture of the fluctuating signal as a function of time. The systems were used to analyze fluctuating signals from semiconductor detectors, photomultiplier tubes, and other circuit elements. (J.W.R.)

21990 OPTIMIZATION OF SIGNAL-TO-NOISE RATIO IN THE PRESENCE OF NOISE AND PILEUP FLUCTUATIONS. Bertolaccini, M. (Politecnico, Milan); Bussolati, C.; Cova, S.; De Lotto, I.; Gatti, E. pp 523-35 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The method of double measurement used in determining the resolving time of pulse shaping circuits which are included in semiconductor spectrometers is examined. A theoretical analysis of the effects of the total number of samplings with suitable weights on the optimization of resolution of pulse shaping circuits against noise and pulse pileup is also presented. (B.G.D.)

21991 OPTIMUM FILTERS FOR USE WITH PULSE-HEIGHT ANALYZERS AND FOR SHORT TIME MEASUREMENTS. Nygaard, K. pp 536-9 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A simple experiment was performed which shows that the standard error in measurements of pulses from semiconductor detectors is not equal to the rms noise of the amplifier system. This indicates the optimum filter is one which gives a maximum pulse amplitude or one which has a minimum phase. (J.W.R.)

21992 SIMPLE NONLINEAR FILTER. Nygaard, K. pp 540-3 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A simple double-diode circuit used as a follower for a single delay line clipping filter or an RC-CR filter is described. The follower improves the signal-to-noise ratio of the filter. (J.W.R.)

21993 LOW-NOISE WIDE-BAND CURRENT PREAMPLIFIER FOR USE WITH SEMICONDUCTOR DETECTORS. Millard, J. K.; Blalock, T. V. (Oak Ridge National Lab., Tenn.). pp 476-83 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A low-noise, wide-band current preamplifier was developed for use in fast-signal processing systems for semiconductor detectors. It consists of a single current-gain section with paralleled field-effect transistors in the input stage. The equivalent white-noise current of the preamplifier is about an order of magnitude below that of previously reported current preamplifiers of comparable bandwidth. (J.W.R.)

21994 PROGRESS REPORT ON CURRENT MODULES. Arbel, A. F. (Tennelec Instrument Co., Inc., Oak Ridge, Tenn.). pp 484-94 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Recent work on current modules, concerned with methods of increasing loop-gain while maintaining stability and with circuit blocks performing specific tasks in the signal-shaping of channel is discussed. A high-gain low-noise preamplifier with a controlled shaper is described. (J.W.R.)

21995 SEMICONDUCTOR DETECTOR AS A SIGNAL GENERATOR. Chase, R. L. (Brookhaven National Lab., Upton, N. Y.). pp 376-80 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

It is shown that significant improvement in signal amplification in circuits containing semiconductor detectors can be obtained by adding low-noise input elements in parallel until the net amplifier capacitance is equal to the detector capacitance. (J.W.R.)

21996 PREAMPLIFIERS. Goulding, F. S. (Univ. of California, Berkeley). pp 381-92 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Extraneous factors and circuit characteristics which affect the performance of semiconductor detector spectrometers are discussed. The characteristics of preamplifiers and field-effect transistors are examined in detail. (J.W.R.)

21997 FIELD-EFFECT TRANSISTOR NOISE AS A FUNCTION OF TEMPERATURE AND FREQUENCY. Radeka, V. (Brookhaven National Lab., Upton, N. Y.). pp 393-401 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Measurements were performed to determine the characteristic features of field-effect transistor noise as a function of temperature and frequency. The results indicate that it is possible to achieve low 1/f noise compared with white noise in the 5 to 10 kHz. The mechanisms responsible for the increase of noise are associated with short time constants. (J.W.R.)

21998 NOISE SOURCES IN METAL–OXIDE–SEMICONDUCTOR AND JUNCTION FIELD-EFFECT TRANSISTORS. Sah, C. T. (Univ. of Illinois, Urbana). pp 402-10 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The mechanisms responsible for low-frequency noise in junction field-effect transistors and metal oxide semiconductors are discussed. Data from narrow-band noise measurements are presented. (J.W.R.)

21999 CHARACTERISTICS AND REQUIREMENTS OF PULSE AMPLIFIERS FOR USE WITH GERMANIUM(LITHIUM) DETECTORS. Fairstein, E. (Tennelec Instrument Co., Inc., Oak Ridge, Tenn.). pp 411-20 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Recent progress in the development of amplifiers for high-resolution Ge(Li) detectors is described. Amplifier characteristics discussed include noise, detector rise-time variations, count-rate capability, and gain stability. (J.W.R.)

22000 VERSATILE PREAMPLIFIER FOR SEMICONDUCTOR DETECTORS PROVIDING HIGH-RESOLUTION CAPABILITY AT HIGH AND LOW COUNTING RATES. Sherman, I. S. (Argonne National Lab., Ill.). pp 424-30 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The design and performance of an FET preamplifier for semiconductor detectors which provides high-resolution at both high and low counting rates are described. (J.W.R.)

22001 INDIUM ANTIMONIDE. Dearnaley, G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 366-7 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The properties of indium antimonide which affect its use as a detector material are described. (J.W.R.)

22002 A NEW METHOD TO REJECT X-RAYS FROM ENERGY RANGE 30 TO 150 keV: APPLICATION TO THE IMPROVEMENT OF THE ANGULAR RESOLUTION OF AN X-RAY DETECTOR. Bui Van, A.; Vedrenne, G. (Centre d'Etude Spatiale des Rayonnements, Toulouse. CNRS, Toulouse). Nucl. Instrum. Methods, 69: 303-8(Apr. 1969).

Instrumentation advances which are proposed consist in the ability to protect against radiation background x-ray detectors in the energy range 30 to 150 keV. Moreover the proposed techniques can be used to improve the angular resolution to $\leq 1.5°$ with a honeycomb collimator. These possibilities seem particularly fruitful for the study of x-ray sources in space physics. (auth)

22003 SEMICONDUCTOR NUCLEAR-PARTICLE DETECTORS AND CIRCUITS. Proceedings of a Conference, Gatlinburg, Tennessee, May 15-18, 1967. Brown, W. L.; Higinbotham, W. A.; Miller, G. L.; Chase, R. L. (eds.). Nuclear Science Series Report Number 44. Publication 1593. Washington, D. C., National Academy of Sciences, 1969. 812p. $25.00. (CONF-670520).

Separate abstracts were prepared for 72 of the papers included. Two papers were previously abstracted in NSA as 21: 26163 and 43247. (J.W.R.)

For abstracts of individual papers see: 21979–22001, 22004–22031, 22064–22077, 22080–22083, and 22146–22148.

22004 BASIC LIMITATIONS ON DETECTOR PERFORMANCE. Dearnaley, G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 5-18 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Inherent properties of semiconductor materials which place limitations on detector performance are described. Factors affecting both energy resolution and response time are discussed. (J.W.R.)

22005 ACCURATE DETERMINATION OF THE IONIZATION ENERGY IN SEMICONDUCTOR DETECTORS. Pehl, R. H.; Goulding, F. S.; Landis, D. A.; Lenzlinger, M. (Univ. of California, Berkeley). pp 19-36 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Precise measurements were performed in order to determine the ionization energy for electrons and alpha particles in Ge and Si detectors. Results for Si detectors indicate a much smaller difference in the energies for the respective particles than had been found previously. The data for Ge detectors, while not conclusive, indicate the ionization energies for both particles are the same. Possible reasons for the difference found in Si detectors are suggested. (J.W.R.)

22006 PULSE-HEIGHT DEFECTS DUE TO NUCLEAR COLLISIONS, MEASURED WITH A THIN-WINDOW SILICON SURFACE BARRIER DETECTOR. Forcinal, G.; Siffert, P.; Coche, A. (Nuclear Research Center, Strasbourg). pp 37-49 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Pulse-height spectra were measured for protons, alpha particles, N ions, and Ne ions using a thin-window silicon surface barrier detector in order to determine energy losses due to nuclear collisions. The results were compared with theoretical pulse-height defects. (J.W.R.)

22007 THE FANO FACTOR IN GERMANIUM AT 77°K. Bilger, H. R. (Argonne National Lab., Ill.). pp 50-62 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Pulse-height spectra for several gamma sources were measured with a Ge detector at 77°K and the Fano factor was calculated from the data. A value of 0.129 was obtained and it was concluded that the Fano factor is essentially energy-independent over the energy range considered. (J.W.R.)

22008 COMMENTS ON MEASUREMENTS OF EPSILON AND THE FANO FACTOR. Walter, F. J. (Oak Ridge Technical Enterprises Corp., Tenn.). pp 63-70 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Problems which limit the accuracy of measurements for epsilon and the Fano factor for semiconductors are surveyed. The validity of using the Fano factor in describing detector performance is discussed. (J.W.R.)

22009 PLASMA EFFECTS IN SEMICONDUCTOR DETECTORS. Tove, P. A.; Seibt, W. (Uppsala Univ.). pp 71-9 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A simple model was formulated and calculations were performed for the plasma time in semiconductor detectors. Results for protons and alpha particles in silicon agree well with experimental values for particular geometries. (J.W.R.)

22010 EXPERIMENTAL RESULTS ON THE DRIFT VELOCITY OF HOT CARRIERS IN SILICON AND ASSOCIATED ANISOTROPIC EFFECTS. Alberigi Quaranta, A. (Univ., Modena, Italy); Martini, M.; Ottaviani, G.; Redaelli, G.; Zanarini, G. pp 80-7 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The drift velocity of hot carriers in silicon was measured for two orientations of the electric field and for several temperatures between 77 and 300°K. An anisotropic effect was observed for hot carriers which is opposite to that for electrons. The data are in reasonable agreement with published values. (J.W.R.)

22011 TRAPPING PHENOMENA IN SEMICONDUCTOR DETECTORS. Mayer, J. W. (Hughes Research Lab., Malibu, Calif.). pp 88-100 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C.; National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The experimental and theoretical data on the loss of collected charge and degradation in resolution of semiconductor detectors due to trapping phenomena are surveyed. (J.W.R.)

22012 TIMING RESPONSE VARIATION WITH TEMPERATURE FROM A PLANAR GERMANIUM(LITHIUM) DETECTOR. Tavendale, A. J. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). pp 130-7 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Timing responses were measured for a planar contact Ge(Li) detector at 124, 78, and 30°K. The measurements indicate that the time response improves with decreasing temperature. (J.W.R.)

22013 TRAPPING MEASUREMENTS IN GERMANIUM(LITHIUM) DETECTORS. Webb, P. P. (RCA Victor Co., Ltd., Montreal). pp 138-43 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Trapping measurements were performed for Ge(Li) detectors made by four different manufacturers using a ^{137}Cs gamma source. The measurements indicate some brands show a preferential trapping of electrons while others show a preference for hole trapping. (J.W.R.)

22014 SURFACE NOISE IN SEMICONDUCTOR DETECTORS. Buck, T. M. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 144-55 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Evidence for a simple model which has been useful in understanding and controlling surface-generated noise in semiconductor detectors is reviewed. Additional noise mechanisms that have come to light are discussed. (J.W.R.)

22015 HIGH-VOLTAGE OPERATION OF LITHIUM-DRIFTED SILICON DETECTORS USING A SHELF STRUCTURE. Goulding, F. W.; Lothrop, R. P. (Univ. of California, Berkeley). pp 156-9 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The design of a Si(Li) detector using a shelf structure in order to improve the high-voltage performance is described. Detectors of this design show no turn-up in leakage current up to 3 kV. (J.W.R.)

22016 LITHIUM DRIFTABILITY IN GERMANIUM. Lopes da Silva, G.; Henck, R.; Siffert, P.; Coche, A. (Nuclear Research Center, Strasbourg). pp 201-6 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Precipitation curves, diffusion constants, and carrier mobilities were measured for lithium in germanium to obtain information on lithium driftability in germanium crystals. Driftability was affected both by oxygen content and vacancies in the crystal. It was found that the diffusion constant was reduced drastically at room temperature. (J.W.R.)

22017 DRIFTABILITY OF GERMANIUM CRYSTALS. Williams, R. L. (Texas Instruments, Inc., Dallas). pp 207-13 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Data from precipitation studies were analyzed to determine the correlation between oxygen content and slow drifting in Ge(Li) crystals. Results show that precipitation studies can be used with confidence in determining oxygen content in high-lifetime high-mobility germanium crystals. (J.W.R.)

22018 COMPARISONS OF DETECTOR OUTPUT PULSE HEIGHTS. Trammell, R.; Walter, F. J. (Oak Ridge Technical Enterprises Corp., Tenn.). pp 221-6 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

In placing Ge(Li) detectors in parallel in close-packed arrays the problem of variations in detector charge output from unit to unit is encountered. In order to obtain a preliminary insight into the problem of obtaining closely matched detectors, the output pulse heights for 33 consecutively produced Ge(Li) detectors were measured. A significant spread in pulse heights was found. (J.W.R.)

22019 EFFICIENCY CONSIDERATIONS IN GERMANIUM (LITHIUM) DETECTORS. Webb, P. P. (RCA Victor Co., Inc., Montreal). pp 227-9 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Efficiencies for several different Ge(Li) detectors were measured as a function of cleanup time following a standard rediffusion. A wide variation in the time required for cleanup was found. (J.W.R.)

22020 ENERGY DEPENDENCE OF GERMANIUM(LITHIUM) DETECTOR EFFICIENCY. Cline, J. E. (Idaho Nuclear Corp., Idaho Falls). pp 241-6 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Efficiency measurements were made for six Ge(Li) detectors of various sizes and types using γ rays of 50 keV to 10 MeV in order to determine the energy dependence of efficiency. (J.W.R.)

22021 ENERGY DEPENDENCE OF GAMMA-RAY LINE-WIDTHS IN GERMANIUM(LITHIUM) DETECTORS. Heath, R. L. (Idaho Nuclear Corp., Idaho Falls). pp 247-51 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Some data on the energy dependence of γ-ray line-widths measured by Ge(Li) detectors are presented. The phenomenon of peak broadening is discussed and a model for explaining these effects is proposed. (J.W.R.)

22022 DETECTOR EFFICIENCIES: A CLARIFICATION OF TERMS. Heath, R. L. (Idaho Nuclear Corp., Idaho Falls). pp 252-7 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The problem of finding a unique definition of efficiency for semiconductor detectors is discussed. The question of what measurements best describe detector performance is examined. (J.W.R.)

22023 PULSE-HEIGHT DEFECT DUE TO ELECTRON INTERACTION IN THE DEAD LAYERS OF GERMANIUM(LITHIUM) GAMMA-RAY DETECTORS. Strauss, M. G.; Larsen, R. N. (Argonne National Lab., Ill.). pp 258-79 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A study was made to determine the extent to which electron interactions in the dead layers of Ge(Li) detectors affect the γ energy spectra. A pulse-shape discrimination system was used to identify the slow pulses due to the dead layer interactions. The system may be used to reject defective pulses due to the dead layer interactions. (J.W.R.)

22024 CONTACT EFFECTS. Mayer, J. W. (Hughes Research Lab., Malibu, Calif.). pp 284-6 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The principal mechanisms for contact effects in semiconductor detectors are discussed and possible ways for distinguishing these effects from trapping effects are suggested. (J.W.R.)

22025 ION IMPLANTATION. Mayer, J. W. (Hughes Research Lab., Malibu, Calif.). pp 287-302 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Techniques for ion-implantation in semiconductor detectors are discussed and the characteristics of implanted layers are described. Implantation kinetics are discussed with a view toward devising some fabrication techniques. (J.W.R.)

22026 WINDOWS ON SURFACE-BARRIER DETECTORS. Siffert, P. (Nuclear Research Center, Strasbourg). pp 303-5 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The thickness of the silicon oxide window on surface-barrier detectors was determined as a function of applied bias and also as a function of material resistivity. The data were compared with calculations assuming some simple acceptor distributions. (J.W.R.)

22027 SILICON DIODE ARRAY FOR IMAGE SENSING. Buck, T. M. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 306-10 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The position-sensitive detector described is an image sensor for photons and electrons with energy greater than the band gap. It is a camera-tube target, a dense array of silicon photodiodes which takes the place of an antimony trisulfide target in a vidicon-type TV camera tube. (J.W.R.)

22028 MATRIX-ADDRESSED DIODE ARRAY. Kandiah, K. (Atomic Energy Research Establishment, Harwell, Eng.). pp 311-13 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A photodiode array suitable for an all-solid-state camera is described. (J.W.R.)

22029 A PARTICLE DETECTOR PROVIDING CHARGE GAIN BY MEANS OF A FORM OF LOCAL TRANSISTOR ACTION. Madden, T. C.; Miller, G. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 314-22 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The use of built-in transistor structure in semiconductor detectors as a means of providing charge gain is discussed. A detector is described in which transistor action was achieved with no base region. (J.W.R.)

22030 AVALANCHE MULTIPLYING DIODE. Huth, G. C. (General Electric Space Sciences Lab., Philadelphia). pp 323-8 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The design and operating characteristics of a silicon diode which uses a direct, high-field avalanche as a charge gain mechanism is described. The device is able to detect 1.5 keV x rays at 85 to 100°C with 30 to 40% efficiency while maintaining very low background. (J.W.R.)

22031 GAMMA-RAY COMPENSATION OF GERMANIUM. Borkowski, C. J.; Fox, R. J. (Oak Ridge National Lab., Tenn.). pp 333-6 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The performance of a germanium detector compensated with acceptor defects produced by ^{60}Co gamma rays is described. The advantages of gamma compensation over lithium compensation for germanium are discussed. (J.W.R.)

22032 AUTOMATIC COUNTER FOR RADIOACTIVE DEPOSITS ON PLANCHETS. Lloyd-Jones, C. P.; Skerrett, E. J. (Univ. of Bristol, Eng.). Analyst, 94: 236-41(1969).

An apparatus is described that automatically end-window counts radioactive deposits on each of twenty-four planchets. Each sample is introduced in turn into a lead castle and counted for a predetermined time to give a printed record of both the radioactivity and the sample number. A recorder previously described (Analyst, 89: 782(1964)) for recording radioactivity in chromatographic column eluates is incorporated in the apparatus. (auth)

22033 NUCLEONIC INSTRUMENTATION. Proceedings of Conference, University of Reading, Eng., 23–25th Sept. 1968. IEE Conference Publication No. 47. London, Institution of Electrical Engineers, 1968. 235p. 70s. (CONF-680939).

Separate abstracts are included for each of the 31 papers presented. Topics discussed were included in the following headings: industrial; reactor instrumentation; on-line computers; physics research; health physics and medicine. (UK)

For abstracts of individual papers see: 21816, 22034, 22035, 22037–22040, 22084–22086, 22095, 22103, 22104, 22106, 22107, 22131–22137, 23841, 23881–23883, 23978, 23979, and 24036–24038.

22034 A NEW COMBINED WIDE RANGE PERIOD METER AND LINEAR NEUTRON FLUX MEASURING CHANNEL PARTICULARLY SUITABLE FOR USE WITH IN CORE DETECTORS. Wilson, I. (Atomic Energy Establishment, Winfrith, Eng.). pp 52-9 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

For a variety of reasons the early transistor designs of wide range mean current period meters now used on several reactors in the U. K. do not fulfill contemporary reactor control requirements. This is true particularly in the case of a reactor using high temperature in-core ionization chambers and mineral insulated cables. These early designs, employing thermionic valves in their logarithmic amplifier and period sections, are not as stable, durable, or easy to maintain as some applications demand. The logarithmic amplifier usually has to be located near the ionization chamber, necessitating a separate head amplifier. The upper limit of current measurement is not compatible with the higher levels which can be encountered with in-core detectors. To overcome these problems, and to exploit later developments in logarithmic amplifiers and related techniques, a new all solid state instrument is described. (auth) (UK)

22035 NEW FAST ANALOG MODULES FOR NUCLEAR INSTRUMENTATION. Herbst, L. J. (Rutherford High Energy Lab., Chilton, Eng.). pp 174-81 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

In nuclear physics experiments, particularly at the higher energies, there is a need for fast instrumentation capable of handling analogue and digital signals with rise times of a few nanoseconds. A further requirement is to have the units d.c. coupled wherever possible, in order to obtain rate-independent performance. A number of modules have been developed on these lines for experiments on the proton linear accelerator of the Rutherford High Energy Laboratory. These units are intended for working with pulses obtained from fast scintillation counters and are designed to handle rates up to 10 MHz. The characteristic impedance of the interconnecting coaxial cables is 100 ohm, but some of the modules can also be used for 50 ohm working. All units are housed in a single width AERE 2000 series frame and conform to 2000 series practice. Several of these modules having general application are described. (auth) (UK)

22036 FOUR CHANNEL AIR MONITOR (Engineering Materials). (du Pont de Nemours (E. I.) and Co., Wilmington, Del.). (CAPE-1858).

5 drawings.

An instrument is described for continuously monitoring airborne contaminants by accepting signals from four scintillation detectors which are mounted on a standard laboratory air sampler. The monitor readily detects β concentrations of 0.5×10^{-9} μCi/cc. For α particles the monitor will detect 20×10^{-12} μCi/cc activity in the presence of maximum background. (For details see TID-4100 Suppl. 53) (see also 23: 11755). (F.S.)

22037 DESIGN AND PERFORMANCE OF A LOW BACKGROUND X-RAY PROPORTIONAL COUNTER FOR THE DETERMINATION OF ^{239}Pu IN HUMAN LUNGS. Taylor, B. T. (Atomic Energy Research Establishment, Harwell, Eng.). pp 215-22 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

For radiological protection purposes it is necessary to be able to measure less than 16 nCi of Pu-239 in the human lung if satisfactory operational control of the inhalation hazard of insoluble plutonium is to be maintained. This amount of Pu-239 gives a dose rate of 0.3 rem per week averaged throughout lung tissues, which is the maximum permissible recommended by I.C.R.P. A highly sensitive detection system is needed for external counting of the uranium L x-rays (energies 13.6, 16.9 and 20.2 keV) which are emitted following 4% of the α-disintegrations of Pu-239. Since their half value thickness in soft tissue is approximately 0.6 cm, only about 3 per cent of those x-rays emitted in the lung will penetrate a chest wall of thickness of 3 cm of soft tissue. The half value thickness in bone is 0.03 cm, and there is negligible transmission through the rib bones; the effect of the rib cage is to reduce the x-rays emerging from the lung by about a factor 2. Thus if a detector has a sufficiently large sensitive area to obtain a geometrical efficiency of 10% for radiation emitted in the lung, the number of x-rays incident on the detector from 16 nCi is about 2 per minute. These considerations dictate that the detector must have a very low background in the energy range of interest, and at the same time a sufficiently large sensitive counting area. The sensitivity to gamma radiator should also be low, to minimize contributions to the background due to the presence of natural K-40 and fall-out Cs-137 distributed throughout the body. The gas-filled proportional counter appears the most suitable detector for this application, and this paper describes the development of a suitable counter at A.E.R.E. (auth) (UK)

22038 SEMICONDUCTOR NUCLEAR RADIATION DETECTORS FOR MEDICAL APPLICATIONS. Abson, W.; Allsworth, F. L.; Salmon, P. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 206-14 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

This paper describes work at A.E.R.E., in collaboration with a number of Medical "user" centres, on the development of silicon detectors suitable for β and γ ray measurements in medical and biological applications. Most of the detector designs for general measurements have had parallel plate electrodes on either side of flat plates of silicon, and this shape is suitable in medical applications for superficial measurements on or near the body. A cylindrical form of probe is often more suitable for in-vivo measurements, and a coaxial detector geometry can make more efficient use of the space available inside a cylindrical case. Detectors with a coaxial geometry have been developed at A.E.R.E. to the stage where they have a sufficiently low noise performance to make them useful for β activity measurements. A general design requirement for medical applications is that the devices can be chemically sterilized, and be robust enough to withstand the pressure and/or stresses involved in holding them firmly in contact with the body surfaces or introducing them into body cavities, etc. Two distinct modes of use are described: (a) Pulse counting for the measurement of β and γ activity; the applications here include cancer diagnosis, gastro-intestinal probes for the location of bleeding in the intestinal tract, and the study of blood circulation in specific organs; (b) γ dose-rate measurement in terms of the mean current generated in the detector, with applications in radio-therapy. (auth) (UK)

22039 SEMI-CONDUCTOR DETECTORS FOR USE IN THE CURRENT MODE. Moat, A. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Piper, D. G.; Silbert, M. G. pp 132-8 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

It is stated that few references are available specifically on current mode applications of semiconductor detectors; among these are Kuckuck et al., (Report UCRL 14405), and Wirth and Rogers (IEEE Trans. Nucl. Sci. NS-11, No. 3(1964)), who have reported on the response of diffused units to high fluxes of gamma radiation. In such applications the detector output current must faithfully follow rapid variations of the input ionization. Typically, the accuracy required might be 3%, with time resolutions in the range 2 to 100 ns. The application described arises in the Los Alamos programme of neutron cross section measurements using an underground nuclear explosion as neutron source; the neutrons arrive at the detection area over a period of several milliseconds, their energy at any time being determined by the time-of-flight relation $t_{(ns)} = [72.3L\ (\text{metres})/\sqrt{E}\ (\text{MeV})]$. To obtain the best possible energy resolution the detection system should have a response time less than the source emission time, and 100 ns has been the aim in the work described. Because of wide variations in the neutron flux and the reaction cross sections the detector current may swing rapidly over several decades. Consequently the detector response must be carefully examined to ensure that no tails are present which could mask deep narrow valleys in the cross sections. Other applications for current mode detectors are appearing, particularly for pulsed X-ray detection. Surface barrier detectors have also been successfully used for examining the detailed pulse shape of the radiation from a plasma device. (auth) (UK)

22040 RECORDING SYSTEM WITH A WIDE DYNAMIC RANGE AND GOOD TIME RESOLUTION. Gore, W. G.; Moss, E.; Warburton, H. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 139-46 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

In recent years experiments have been carried out to obtain nuclear data using an underground nuclear explosion as a source of bombarding neutrons. In an explosion experiment it is not possible to record individual events and current outputs from semiconductor detectors are measured, the experiments being designed so that sufficient events occur during one resolving time to give accurate results. A specialized recording system is required for this type of experiment, since signal levels from the detectors can vary over a range of five decades and time resolution of the order of 10 nS is needed over a period of up to 10 milliseconds, i.e., one part in 105. An amplitude measurement accuracy of 2% is also required. In the design of such equipment no estimates were made regarding the nature of the waveform to be measured, and it was assumed that rapid and extreme changes of signal level could occur at random. In a typical underground nuclear firing the nuclear device is located approximately 1,000 feet below ground level and neutrons are brought to the surface through an evacuated flight tube. Above ground the neutron beam passes through a variety of experimental systems, which are mounted in a tower perhaps 70-80 feet high. The apparatus described was used to record neutron-induced reactions in samples placed in the path of the beam, reaction products being detected by solid state devices mounted at appropriate angles just off the beam axis. Signals from the detectors were taken to amplifiers via short lengths of cable and thence, via much longer cables, to recording equipment housed in a shed close to the tower base. After the device was fired the recording equipment was drawn clear of the tower area by a winch before ground subsidence and crater formation took place. Part of a typical result, the Pu-238 fission cross section, is shown graphically. (auth)

22041 ANGULAR RESPONSE OF SPHERICAL PLATE ELECTROSTATIC ANALYZERS. Theodoridis, George C.; Paolini, Frank R. (American Science and Engineering, Cambridge, Mass.). Contract F19628-67-C-0277. Rev. Sci. Instrum., 40: 621-42(May 1969).

The transmission characteristics of spherical plate electrostatic analyzers are examined for external particle sources, as functions of angular coordinates α and β, and particle energy E. The angle α is in the plane of the particle's trajectory; β is in the plane containing the point of incidence and perpendicular to the radius vector from the center of electrostatic force. The total energy-geometrical factor F, which is the ratio of transmitted particle flux (particles/sec) to directional intensity (particles/$\text{cm}^2 \cdot \text{sec} \cdot \text{sr} \cdot \text{keV}$), is expressed in the functional form $F \equiv G_{\alpha\beta E} A\beta_0 \Delta\alpha \Delta E$, where β_0 and $\Delta\alpha$ are angular parameters and ΔE the energy resolution, all appropriately defined. Methods are given for determining the function G and some specific examples are presented. It is shown that G is of the order of unity. A surprising result is that β_0, which is a measure of the angular aperture in β space, may differ appreciably from the value expected intuitively on the basis of the angular dimensions of analyzer plates. The angles α and β are locally defined with respect to each arbitrary point of incidence within the entrance aperture. A general method is also given for finding the detailed angular response of spherical plate analyzers in a frame of reference fixed with respect to the analyzer plates. (auth)

22042 HIGH ENERGY ELECTRON BEAM MONITOR. Crannell, Carol Jo; Crannell, Hall; Zeman, H. D. (Stanford Univ., Calif.). Contract Nonr. 225(67). Rev. Sci. Instrum., 40: 661-83(May 1969).

A high energy electron beam monitor which detects the Cherenkov light emitted in nitrogen gas at atmospheric pressure is described. The monitor is designed to have a constant sensitivity to electrons of energies above 200 MeV, to have a response time of less than 10^{-7} sec, and to have a current output which is linearly proportional to the beam intensity over a range of five decades. The results of tests made on the monitor are presented. The tests show that the monitor has a sensitivity, speed, range, and lack of dependence on beam position and background radiation which make it ideal for many monitoring applications. (auth)

22043 DEGRADATION OF CONTINUOUS-CHANNEL ELECTRON MULTIPLIERS IN A LABORATORY OPERATING ENVIRONMENT. Frank, L. A.; Henderson, N. K.; Swisher, R. L. (Univ. of Iowa, Iowa City). Contracts NAS5-9074; NAS5-9156. Rev. Sci. Instrum., 40: 685-9(May 1969).

Measurements of the counting rates (~10^3 to 10^4 counts/sec) of continuous-channel electron multipliers mounted in an electrostatic analyzer responding to a monoenergetic beam of electrons, while operating in a vacuum chamber at a pressure ~3×10^{-6} Torr attained with an oil diffusion pump, display a degradation of their gain (fatigue) which is proportional to the accumulated counts. The useful lifetime of these devices when employed with fixed-threshold pulse amplifiers is defined here as the accumulated counts until gain degradation has produced a reduction of the counting rates to 15% of the initial responses at an operating bias voltage of 4000 V and constant stimuli. The lifetimes of these particle detectors in this laboratory environment are ~10^{10} counts or, for example, an average counting rate of 300 counts/sec for one year. Comparison of this laboratory lifetime with the responses of similar instrumentation which has been flown on the earth satellites OGO's 3, 4, and 5 and IMP 4 demonstrates that the expected lifetimes for these electron multipliers in a spaceflight environment are several years. Efficiencies of an electron multiplier for counting monoenergetic electrons over an energy range ~60 to 50,000 eV are also presented. (auth)

22044 TWISTED CRYSTAL X-RAY SPECTROMETER. Fraenkel, B. S. (Hebrew Univ., Jerusalem). Rev. Sci. Instrum., 40: 732(May 1969).

A twisted crystal x-ray spectrometer using quartz and germanium crystals is described. The reflecting plane of a flat crystal plate is converted into a spiral reflecting surface giving a whole spectral range of possible lines simultaneously from each very brief spark or from a distant point source such as a star. (C.E.S.)

22045 IMPROVEMENT OF ENERGY RESOLUTION IN HUGHES-McMILLEN 127° ELECTROSTATIC ENERGY SELECTOR. Salop, A.; Golden, D. E.; Nakano, H. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Rev. Sci. Instrum., 40: 733-5 (May 1969).

It is shown that a significant improvement of energy resolution can be obtained in large electrostatic energy analyzers by suitably focusing and limiting the electron beam before entrance into the monochromator. (B.G.D.)

22046 A ^{14}C DATING LABORATORY, USING CO_2 AS INTERNAL COUNTING GAS. Cazeneuve, Horacio A. (Univ. of La Plata). Ark. Geofys., 5: 463-74(1969).

The Radiocarbon Laboratory at the University of La Plata, Argentina, is described. The proportional counter design follows that developed at the laboratories of Uppsala and Groningen. The purification of CO_2 is carried out following the method developed by Hl. de Vries. The performance of the complete apparatus is reported. The condition of each component of the background and its relationship with the shield is analyzed. The counting rate for the background is 1.33 cpm, and modern carbon 9.80 cpm. (auth) (Swed)

22047 ULTRAVIOLET SENSITIVE GEIGER TUBE OPERATING CIRCUIT WITH REVERSE QUENCH VOLTAGE. Engh, Robert O. (to Honeywell Inc.). U. S. Patent 3,435,225. Mar. 25, 1969. Filed Dec. 27, 1965.

An ac operating circuit in combination with an ultraviolet sensitive Geiger tube is disclosed. The ac circuit includes a diode and two resistors arranged to provide an operating voltage to the Geiger tube during first half cycles and a relatively low quenching voltage to it during opposite half cycles, which quenching voltage provides a clearing field within the tube for de-ionizing the gas fill. (Offic. Gaz.)

22048 BEAM POSITION DETECTOR. Sorensen, Hans O. (to Hewlett-Packard Co.). U. S. Patent 3,435,232. Mar. 25, 1969. Filed Mar. 3, 1966.

A target is described which includes an array of detectors of electromagnetic radiation which provides signal outputs related to the rectangular coordinates of the position of the beam of the target. (Offic. Gaz.)

22049 NEUTRAL-ATOM DETECTOR. Bernstein, William; Wax, Robert L. (to TRW, Inc.). U. S. Patent 3,435,214. Mar. 25, 1969. Filed Apr. 25, 1967.

An apparatus for detecting an incident beam or flux of neutral atoms, such as hydrogen atoms, in the energy range from 1 to 20 keV is described using a fixed geometry and yet obtaining both ultraviolet insensitivity and energy independence within the range of energies for which the apparatus is designed. By this is meant that where two incident fluxes are of equal intensity, they will be registered by the detector apparatus as equal irrespective of whether they have the same energy value. This is achieved by passing the incoming beam through a deflection system to remove charged particles, causing the remaining beam of neutral particles to be scattered by a thin foil, and positioning a detector for the scattered particles at a critical angle such that for that angle the relative scatter for particles of different energies within the design energy range is the same. (Offic. Gaz.)

22050 SEMICONDUCTOR DETECTORS. Grenier, G. (CEA, Paris). Nucleus (Paris), 9: 378-90(1968). (In French).

The general characteristics of semiconductors are outlined briefly, and the properties of the p-n junction are given. The principal characteristics of semiconductor detectors and the associated electronics are reported, and the interaction of different radiations with semiconductor detectors is described. Various types of detectors and their applications are discussed. (J.S.R.)

22051 RADON-DAUGHTER EXPOSURE MEASUREMENT WITH TRACK ETCH FILMS. Rock, R. L. (Bureau of Mines, Denver); Lovett, D. B.; Nelson, S. C. Health Phys., 16: 617-21 (May 1969).

The registration of alpha particles in cellulose nitrate dielectric films may be used as a basis for an exposure integrating device to measure the individual worker's exposure to alpha particle irradiations from radon and radon daughter products in mine atmospheres. These films are insensitive to beta, gamma and light radiations and to alpha activity plated-out on the surface. Tests in mine atmospheres indicated good correlation between film track densities and measurements of the mine atmospheres by standard filtered air samples. (auth)

22052 CALIBRATION OF INSTRUMENT FOR MEASUREMENT OF RADON CONCENTRATIONS IN MINE ATMOSPHERES. Waters, John R.; Howard, B. Y. (Johnston Labs., Inc., Cockeysville, Md.). Health Phys., 16: 657-9(May 1969).

A portable ionization chamber survey instrument was calibrated for radon gas and shown to have adequate sensitivity for measuring radon levels encountered in uranium mines. The instrument contains compensation, so that it is unaffected by weak ambient gamma-ray fields; it also includes filtration to remove aerosols, dust and free ions all likely to be present in the mine atmosphere. (auth)

22053 TRACK ETCH DETECTORS FOR ALPHA EXPOSURE ESTIMATION. Lovett, D. B. (General Electric Co., Pleasanton, Calif.). Health Phys., 16: 623-8(May 1969).

Solid state dielectric detectors have been applied as integrating alpha particle monitoring devices to permit the estimation of alpha particle lung doses received by workers in radon-radon daughter contaminated atmospheres. The characteristics of these detectors are discussed and the results of laboratory and field testing are summarized. (auth)

Nuclear Spectroscopic Instrumentation

22054 (CEA-CONF-1251) BETA MAGNETIC MANY PATH SPECTROMETRY. Schussler, Francois (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1968]. 5p. (In French). (CONF-681208-10). Dep.

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France.

A ten-channel, magnetic (uniform field) beta spectrometer was realized in order to study either single or β-γ coincidence spectra up to 10 MeV (resolution: 2%, transmission: 10^{-3}). Half lives down to 20 s can be reached, but connected on-line with an isotope separator, it should be useful to study half lives shorter than 20 s, provided that the activity is sufficient. (auth)

22055 (CEA-R-3747) DESCRIPTION OF A MULTIMODE GAMMA SPECTROMETER. Chardine, Joeel; Haouat, Gerard; Humeau, Claude; Lachkar, Jean; Sigaud, Jean (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes); Roquefort, Henri (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb. 1969. 47p. (In French). Dep.

A multimode gamma spectrometer known as the SGMM 10 is described. It can detect photons by one of three different modes: total absorption, photoelectric and anti-Compton effect, or the pair effect. These results are recorded in such a way that the experimenter can interpret the measurements according to the mode which is the best adapted to the energy of the photons under study. The instrument is made up of a central detector, a Ge(Li) semiconductor with its cryostat, and an annular crystal, a large volume NaI(Tl) scintillator consisting of four optically isolated sectors. The energy and time data produced by these detectors are processed by an electronic unit. (auth)

22056 (FEI-129) THE DOUBLE SPECTROMETER OF SLOW NEUTRONS DIN-1. Liforov, V. G.; Novikov, A. G.; Nozik, V. Z.; Orlov, V. V.; Parfenov, V. A.; Semenov, V. A.; Bagdasarov, P. E.; Klemyshev, P. S.; Smirnov, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1968. 26p. (In Russian). Dep.

A physical description is given of the DIN-1 double spectrometer at the IBR-I reactor at Dubna. The basic characteristics of the spectrometer and the intensity of the monochromatic neutrons are reported. On the basis of measurements made with the spectrometer, it was concluded that the IBR-I fast pulse reactor is an effective source of slow neutrons for the study of the physics of condensed states. A series of refinements made in 1968 significantly improved the characteristics of the spectrometer. The feasibility of the design DIN-II on the reactor IBR-2 permits the resolution to be greatly improved. (J.S.R.)

22057 RESPONSE OF AN ELECTRON SPECTROMETER AT LOW ENERGIES. McConnell, W. J.; Birkhoff, R. D. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 69: 209-12(Apr. 1969).

All spectrometers although they reject spurious signals to some extent have extraneous components in their line profiles. If each line exhibits a low intensity tail, a continuum composed of such lines will be found to be erroneously high in the region where the tails pile up. For optical and mass spectrometers this is usually not a problem because their dynamic ranges are short. However, this is not the case for some electron spectrometers, particularly for the Keplertron, which has a dynamic range from 1 to 40,000 eV. To determine the Keplertron's response, line profiles were obtained with an electron gun to provide a monoenergetic source variable from 50 to 10,000 eV. All line profiles have the same general shape—a large, central peak and a low energy tail which is a factor of 1,000 to 5,000 lower than the central peak. Calculations show that if a hypothetical flat 1 MeV beta ray spectrum were studied, that the spurious tails would produce a 30% extraneous increase in apparent electron flux from the source at 1 keV and a 300% enhancement at 100 eV. The distortion is negligible, however, for electron slowing down spectra which have an E^{-1} shape below 10 keV. (auth)

22058 TIMING OF PULSES FROM SURFACE BARRIER DETECTORS. Emmerich, W.-D.; Hofmann, A.; Stock, R. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods, 69: 225-8 (Apr. 1969).

Both the crossover method and the leading edge method are available for obtaining time marking signals for coincidence experiments. For solid state detectors the two methods are discussed. If it is necessary to avoid counting losses, which distort particle spectra, the leading edge method was found to work well for coincidence resolving times $2\tau \geq 30$ ns (fwhm = 3.4 ns), the crossover method, however, only for $2\tau \geq 90$ ns. This result is due to variations in the rise time of the detector pulses. (auth)

22059 AUTOMATIC SAMPLE CHANGER FOR SOLID STATE ALPHA-SPECTROSCOPY. Kelley, H. L.; Shuping, R. E.; Schneider, R. H.; Moghissi, A. A. (Bureau of Radiological Health, Rockville, Md.). Nucl. Instrum. Methods, 70: 119-20 (Apr. 1, 1969).

An automatic system sample changer for α-spectroscopy using solid state detectors is described. Four samples are counted simultaneously in the system and a total of 24 samples can be loaded at one time. (auth)

22060 SPECTROMETRY OF FAST NEUTRONS WITH A SILICON-SURFACE BOUNDARY-LAYER COUNTER. Piroth, H. D. (Philipps-Univ., Marburg, Ger.). Atompraxis, 15: 51-5(Jan.-Feb. 1969). (In German).

Dosimetry of fast neutrons in larger biological objects requires a neutron spectrometer with minimum volume, high resolving power, and great sensitivity. A procedure using spectra measured with a silicon boundary-layer detector for determining neutron-energy distributions after application of a correction procedure is described. Measurements in a Van de Graaff generator using the $T(d,n)^4He$ nuclear reaction demonstrate the excellent resolving power of this measurement procedure. (auth)

22061 FAST HIGH PRECISION ANALOG-DIGITAL-CONVERTER FOR PULSE SPECTROSCOPY. Patzelt, R. (Reactor Centre, Siebersdorf, Austria). Nucl. Instrum. Methods, 70: 61-8(Apr. 1, 1969).

An ADC with the following specifications has been designed and constructed: 8192 channels, amplitude range 0.05 to 10 V, positive, conversion time 12 μsec, max integral linearity better than $\pm 2.5 \times 10^{-4}$, stability of channel-width 0.5%. In a modification of the linear capacitor discharge a coarse and a fine measurement is executed subsequently, combined of a fast discharge and an interpolation with a slow discharge. The address oscillator works at 20 MHz, the address register is advanced during the coarse measurement in steps of 64 channels and during the fine measurement channel by channel. The discharge current generators are switched in exact synchronism with the pulses of the address oscillator; a two-step-synchronizing circuit is used. Special circuits have been developed for the pulsestretcher, the current-generators, current-switches and the discriminator. The high degree of stability and linearity is achieved through the proper use of field-effect-transistors, linear integrated circuits and fast digital integrated circuits (emitter-coupled logic). Details of the tests performed and the testing methods are given. (auth)

22062 HIGH RESOLUTION WITH NONDISPERSIVE X-RAY SPECTROMETERS. Aitken, Donald W. (Stanford Univ., Calif.). Contract AF49(638)1499. Res. Rev. (Office Aerosp. Res.), 7: No. 9, 1-6(Sept. 1968).

The resolution of various nondispersive detector systems for x-ray spectroscopy is discussed. Ionization chambers, proportional counters, scintillation counters, and semiconductor detectors are considered. (W.H.K.)

22063 VARIABLE TEMPERATURE MOESSBAUER EFFECT SPECTROMETER WITH PROVISION FOR LONGITUDINAL EXTERNAL FIELDS. Swartzendruber, L. J. (National Bureau of Standards, Washington, D. C.). Nucl. Instrum. Methods, 69: 101-5(Apr. 1969).

A Moessbauer effect spectrometer design for obtaining spectra with the absorber in a longitudinal external magnetic field is described. A superconducting magnet is the source of the field. The absorber temperature can be varied between about 300°K and 1.5°K and, independently, the source temperature can be varied between 300°K and about 10°K above the absorber temperature. (auth)

22064 THE IMPACT OF GERMANIUM DETECTORS AT CHALK RIVER. Alexander, T. K. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 780-3 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Experiments in nuclear lifetime measurements, branching ratios, and $\gamma-\gamma$ and particle$-\gamma$ angular correlation studies that have become feasible with Ge(Li) detectors are surveyed. (J.W.R.)

22065 PROTON-DEUTERON DISCRIMINATION WITH A SINGLE SEMICONDUCTOR DETECTOR. Alberigi Quaranta, A. (Univ., Modena, Italy); Martini, M.; Ottaviani, G.; Zanarini, G. pp 767-71 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A charged-particle spectrometer was designed using a surface barrier detector which is capable of proton-deuteron discrimination simultaneous to energy measurements. Measurements in the 4 to 5 MeV range showed good discrimination. (J.W.R.)

22066 A COMPARISON OF PULSE-HEIGHT SPECTROMETER STABILIZER SYSTEMS. Konrad, M. (Columbia Univ., New York). pp 731-9 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Various pulse-height spectrometer stabilizing systems are compared, and some suggestions are made on criteria for obtaining optimum performance. (J.W.R.)

22067 A GERMANIUM(LITHIUM) TWO-CRYSTAL COMPTON SPECTROMETER. Broude, C.; Sharpey-Schafer, J. F.; Hausser, O.; Alexander, T. K. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 688-92 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A Compton spectrometer is described which uses two Ge(Li) detectors and which may be used as a polarimeter. The gamma spectrum of ^{88}Y was measured to check the performance of the spectrometer. (J.W.R.)

22068 COMPTON SUPPRESSION AND PAIR SPECTROMETER. Camp, D. C. (Univ. of California, Berkeley). pp 693-702 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A gamma spectrometer is described which utilizes a Ge(Li) detector partially enclosed by NaI(Tl) scintillation detectors to suppress the Compton distribution. The arrangement may also be used as a pair spectrometer. (J.W.R.)

22069 PROBLEMS IN THE CALIBRATION AND USE OF HIGH-RESOLUTION GERMANIUM(LITHIUM) SPECTROMETER SYSTEMS. Heath, R. L. (Idaho Nuclear Corp., Idaho Falls). pp 642-59 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Limitations on measurements in nuclear gamma spectroscopy imposed by instrumentation are discussed. Problems encountered in the calibration of high-resolution Ge(Li) spectrometers and the importance of the performance criteria for each component of the electronic systems are examined in detail. (J.W.R.)

22070 USE OF GERMANIUM(LITHIUM) DETECTORS IN GAMMA-RAY SPECTROSCOPY: APPLICATIONS AND BASIC CONSIDERATIONS. Bolotin, H. H. (Argonne National Lab., Ill.). pp 660-83 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Some of the fundamental advantages, disadvantages, and limitations on the use of Ge(Li) detectors for gamma singles and coincidence spectroscopy are discussed. Some useful experimental applications are described. Also some extremely valuable experiments are described which are difficult or unfeasible because of detector limitations. (J.W.R.)

22071 REDUCTION OF NOISE IN NUCLEAR-PARTICLE SPECTROMETERS BY USING SWITCHED TIME CONSTANTS AND GATED INTEGRATORS. Kandiah, K. (Atomic Energy Research Establishment, Harwell, Eng.). pp 544-52 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A system of pulse processing is described which requires the minimum number of variable components to optimize for a particular detector–amplifier combination. The reduction in noise is achieved by using switched time constants and gated integrators. (J.W.R.)

22072 TIME-VARIANT FILTERS FOR HIGH-RATE PULSE-AMPLITUDE SPECTROMETRY. Radeka, V. (Brookhaven National Lab., Upton, N. Y.); Karlovac, N. pp 553-69 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Analytical and instructive arguments and experimental evidence are used to show that it is necessary to vary one parameter of the filter in the measurement interval in order to process differentiated signals and achieve a high signal-to-noise ratio. Examples of some simple filters of this kind are given, and some preliminary results are presented. (J.W.R.)

22073 SIGNAL PROCESSING FOR HIGH-RESOLUTION PULSE-AMPLITUDE SPECTROMETRY. Radeka, V. (Brookhaven National Lab., Upton, N. Y.). pp 511-22 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The fundamentals for studies in the use of filters in high-rate, high-resolution pulse-amplitude spectrometry are discussed. Definitions are given for signal and noise in detector-amplifier systems. The theoretical maximum for signal-to-noise ratio and the theoretical minimum for measurement time are discussed. (J.W.R.)

22074 DIRECT-COUPLED PULSE AMPLIFYING AND ANALYZING SYSTEM FOR NUCLEAR-PARTICLE SPECTROMETRY. Kandiah, K.; Stirling, A. (Atomic Energy Research Establishment, Harwell, Eng.). pp 495-505 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The factors responsible for the shortcomings of conventional pulse amplifying and analyzing systems are discussed. A direct-coupled system is described which eliminates some of the problems of conventional systems. (J.W.R.)

22075 THE RELATIVE IMPORTANCE OF VARIOUS RATE-ORIENTED DESIGN FEATURES OF HIGH-RESOLUTION SPECTROMETERS. Rudnick, S. J.; Strauss, M. G. (Argonne National Lab., Ill.). pp 445-54 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

An amplification system was designed for a Ge(Li) detector consisting of a cooled FET preamplifier with pole-zero compensation and an amplifier with pole-zero compensation, pileup rejection, and baseline restoration. Measurements were performed to determine the relative importance of these design features. (J.W.R.)

22076 THE DESIGN AND PERFORMANCE OF A HIGH-RESOLUTION, HIGH-RATE AMPLIFIER SYSTEM FOR NUCLEAR SPECTROMETRY. Goulding, F. S.; Landis, D. A.; Pehl, R. H. (Univ. of California, Berkeley). pp 455-75 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The design and performance of high-resolution, high-rate amplifier system for gamma spectroscopy are described. The system includes pole-zero cancellation, a pileup rejector, and a linear gate. (J.W.R.)

22077 ISOELECTRONIC SCINTILLATORS. Brown, W. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 369-72 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The optical properties of isoelectronic scintillators are discussed. Some of the characteristics of a zinc telluride–oxygen system are described. (J.W.R.)

22078 STUDY OF THE NEUTRON CASCADE IN IRON. Hajnal, F.; Awschalom, M.; Bennett, B. G.; McLaughlin, J. E.; O'Brien, K.; Raft, P. D.; Schimmerling, W. (Atomic Energy Commission, New York). Contract AT(30-10)-2137. Nucl. Instrum. Methods, 69: 245-53(Apr. 1969).

A proton recoil spark chamber neutron spectrometer described earlier was used to study the secondary neutron energy spectra at different angles due to neutrons incident on a thick scatterer. A description of the apparatus, experimental lay-out and results are given. (auth)

22079 HIGH RESOLUTION GAMMA SPECTROMETER WITH A BOREHOLE GERMANIUM DETECTOR. Bueker, H. (Kernforschungsanlage, Juelich, Ger.). Nucl. Instrum. Methods, 69: 293-302(Apr. 1969). (In German).

Description is given for a high-volume lithium-drifted borehole germanium detector and the vacuum chamber in which it is operated. The detector is especially suited for investigations of low gamma-active samples often arising in the fields of medicines, biology, and radiochemistry. The germanium crystal is built into a vacuum-tight casing on which an ion-spray-pump is welded, and by which the detector casing can further be evacuated in case of necessity. Detector canning is designed to permit as easy mounting of the bore-hole detector into the measuring equipment. Moreover, it can easily be transported, and in the state of non-operation easily be stored in dry ice. The detector casing has given evidence for its stability and operation safety. The detector itself is operated in a vacuum chamber which permits to load the detector in the vacuum with the probes designated for investigations. Operation of the vacuum chamber is automatic so that no mistakes in maintenance may occur. During a probation run of several weeks it was shown that the equipment works in full operation safety. Measurements with a probe which had an activity of approximately 0.47 nCi resulted in a resolution of nearly 5 keV (fwhm) with reference to the 662 keV ^{137}Cs-line. The vacuum chamber was designed to permit utilization also for other experiments with semiconductor detectors. (auth)

22080 MULTIPLE-DETECTOR ARRAYS. Lalovic, B. (Boris Kidrich Inst. for Nuclear Sciences, Belgrade). pp 230-6 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Some problems encountered in obtaining good resolution in γ spectrometers using a multiple array of Ge(Li) detectors are discussed. Suggestions are made on methods of matching detectors and on the best volume to use. A four-element spectrometer was used to confirm the branching of the decay of the 1.78-MeV level in the ^{27}Al(p,γ)^{28}Si reaction. (J.W.R.)

22081 A LARGE-VOLUME, HIGH-RESOLUTION GERMANIUM(LITHIUM) SPECTROMETER. Malm, H. L.; Fowler, I. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 237-40 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The development, design, and performance of spectrometers using large-volume, high-resolution Ge(Li) detectors are discussed. (J.W.R.)

22082 INTRODUCTORY REMARKS ON GAMMA DETECTION EFFICIENCY OF GERMANIUM SPECTROMETERS. Walter, F. J. (Oak Ridge Technical Enterprises Corp., Tenn.). pp 214-20 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

The efficiencies of seven consecutively produced cylindrical coaxial Ge(Li) detectors were measured and the values ranged from 2.4 to 2.7%. The problem of constructing a definition and a geometry independent measuring technique for detector efficiencies is discussed. The problems of geometry factors, surface-to-volume ratio, and mysterious volume losses are discussed. (J.W.R.)

22083 PERFORMANCE OF GERMANIUM(LITHIUM) DETECTORS OVER A WIDE TEMPERATURE RANGE. Sakai, E.; Malm, H. L.; Fowler, I. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 101-29 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A study was made of the characteristics of Ge(Li) γ spectrometers over the temperature range 5 to 220°K. Properties studied included resolution, leakage current, transit time, and maximum and minimum operating temperatures. (J.W.R.)

22084 LARGE VOLUME GERMANIUM GAMMA-RAY SPECTROMETERS. Ridley, J. D. (Nuclear Enterprises Ltd., Edinburgh). pp 147-51 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The preparation is described of germanium detectors with volumes of 80 cc. The crystals used had a diameter of 46 mm and were drifted to a depth of 15 mm. (auth)

22085 IMPROVEMENTS IN THE PERFORMANCE OF GERMANIUM DETECTORS FOR GAMMA-RAY SPECTROMETRY. Gibbons, P. E.; Howes, J. H.; Owen, R. B. (Atomic Energy Research Establishment, Harwell, Eng.). pp 152-8 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

Over the last five years gamma ray spectrometry has been revolutionized by the development of lithium-drifted germanium detectors. These detectors have found application in many areas where precise energy measurement or discrimination between gamma rays of similar energies is important. The successful application of the detectors requires that careful attention be paid not only to the detector itself, but also the low temperature cryostat design, the low noise head amplifier, and the ability of the pulse analysing equipment to perform at high count rates with low distortion of the spectrum. The development programme at A.E.R.E. has aimed at optimising all these features. In this paper further developments which are relevant to a more complex exploitation of germanium detectors are discussed. The topics cover cryostat design, low-noise amplifier arrangements, and some relevant detector results. (auth)

22086 RECENT ADVANCES IN THE ANALYSIS OF PULSE HEIGHT DISTRIBUTIONS IN GAMMA-RAY SPECTROMETRY. Salmon, L. (Atomic Energy Research Establishment, Harwell, Eng.). pp 159-65 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The present day use of gamma-ray spectrometry using both sodium iodide and lithium drifted germanium detectors has extended into many fields of physics and chemistry. In particular, routine analyses of radionuclide mixtures are performed by this technique far more rapidly and cheaply than by laborious conventional radiochemical methods. At AERE, for example, several thousand analyses per annum are carried out by this means in the fields of radioactivation analysis, radiotracer applications and the measurement of nuclear weapon debris. The ability to perform so many analyses has depended upon the introduction of suitable data handling methods and appropriate numerical analysis by use of a computer. The purpose of this paper is to introduce some of the more recent variations on this numerical technique with particular reference to those used at AERE. (auth) (UK)

22087 ROCKET BORNE SCINTILLATION SPECTROMETER FOR OBSERVING COSMIC X RAYS. Harri, J.; McGee, M.; Toor, A. (Univ. of California, Livermore). Rev. Sci. Instrum., 40: 703-20(May 1969).

A rocket borne spectrometer system sensitive to 6- to 80-keV photons is described. The system includes a shutter-collimator that makes it possible to measure the contribution to the background due to charged particle interactions in the mass of the rocket payload. Also described is a detector rotation mechanism that allows the look angle of the detector with respect to the rocket axis to be changed during flight. (auth)

22088 INTERNAL ENERGY STANDARDIZATION OF MULTICHANNEL GAMMA RAY SPECTRA BY USE OF THE 0.511 MeV ANNIHILATION AND ^{40}K PEAKS. Grismore, R.; Weitz, W. E. Jr.; Folsom, T. R. (Univ. of California, San Diego, La Jolla). Rev. Sci. Instrum., 40: 642-60(May 1969).

A computer method is described for making after-the-fact adjustments for incorrect zero energy intercept and instrumental gain to experimental gamma ray pulse height spectra from NaI(Tl) scintillation spectrometers. The method makes use of the 0.511 MeV annihilation peak and 1.46 MeV ^{40}K photopeak as internal energy reference standards, both of which peaks are available to NaI(Tl) scintillation detectors. The technique has been tested experimentally and appears to be of practical use for routine energy standardization of long counting time gamma ray spectra between 0.1 and 2.0 MeV. (auth)

22089 ACHIEVEMENTS OF NUCLEAR SPECTROSCOPY IN SOVIET LATVIA. Prokof'ev, P. T. Latv. PSR Zinat. Akad. Vestis, No. 1, 94-9(1969). (In Russian).

A brief review is given on the research carried out by the Latvian Inst. of Physics in the field of spectroscopy. Descriptions are given of the 15 year studies of nuclear properties during radioactive decay and (n,γ) reactions. 34 references. (R.V.J.)

22090 A SIMPLE DEVICE FOR HALF-LIFE MEASUREMENTS OF HIGH GAMMA RAYS EMITTERS. Ortiz, Eddie; Facetti, J. F.; Pinto, Santiago (Puerto Rico Nuclear Center, Mayaguez). Rev. Soc. Cient., 8: No. 1, 13-19(1967).

The basic principle involved is the disintegration of deuterium by high-energy gamma photons to produce fast neutrons, which are moderated by an optimum thickness of paraffin to achieve the best balance between moderation and capture. The moderated neutrons are detected by a BF counter. The detector is made of two concentric polyethylene bottles with a 2 mm gap filled with D_2O. The outer bottle has a diameter of 12.4 cm. The inner bottle is filled with paraffin and a 1.8 cm hole drilled to locate a BF_3 counter. The half-lives of ^{24}Na, ^{37}S, ^{49}Ca, ^{56}Mn, ^{76}As, and fission products from the P.R.N.C. fuel elements were measured. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 22947, 23360, and 23456.

22091 SPARK CHAMBER WITH INDUCTIVE LOCATION. Springer, K.; Poelz, G.; Daniel, H. (CERN, Geneva. Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods, 69: 240-4(Apr. 1969).

In the inductive location method both coordinates of the spark are located by means of signals induced in wire loops around the chamber edges. Spark chambers of this kind have been built and tested. The chambers have electrodes, of size 30 × 30 cm^2, consisting of a phosphor-bronze mesh and are operated with 70% Ne and 30% He at atmospheric pressure. Calibration was done with a light pulser. The resolution obtained is 0.26 mm (fwhm). With protons of 300 MeV the efficiency is found to be >99.3% with a 99% confidence. (auth)

22092 10 kHz BURST GENERATOR. Williams, W. A. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 69: 355-6(Apr. 1969).

This 10 kHz burst generator is an economically constructed, crystal controlled, clock pulse generator whose output is controlled by pulsed signals. Maximum jitter is 10 μsec. (auth)

22093 ESTIMATION OF SCANNING EFFICIENCIES FOR EXPERIMENTS USING VISUAL DETECTORS. Derenzo, S. E. (Univ. of California, Berkeley); Hildebrand, R. H. Contract Nonr-2121(25). Nucl. Instrum. Methods, 69: 287-92(Apr. 1969).

A new technique is presented for estimating scanning efficiencies. The special feature of this technique is that it allows for the tendency of different scanners to miss the same events. Each event is assumed to have a visibility, v, depending both on its own characteristics and on the perceptiveness of the scanners. The distribution of events in visibility is described by a function F(v) whose parameters are determined by comparing the numbers of new events found in each of three or more successive scans. The technique is applied to a study of μ^+ decay events, which have been scanned four times. The true number of events, $N_T = \int_0^1 F(v)\, dv$, found by this technique and a lower limit to N_T found by an alternate technique indicate that the inefficiency estimated by the usual double-scanning method can be low by a large factor. (auth)

22094 POLYETHYLENE SPARK CHAMBER FOR 50 TO 250 MeV NEUTRONS. Pondrom, L. G.; Olsen, S. L.; Barney, J. L. (Univ. of Wisconsin, Madison). Nucl. Instrum. Methods, 69: 282-6(Apr. 1969).

A spark chamber with polyethylene loaded plates has been used to detect neutrons from the decay $\Lambda^\circ \rightarrow n\pi^\circ$. The average detection efficiency for neutrons between 50 and 250 MeV was found to be 12%. The average neutron spin analyzing power was found to be −0.035. (auth)

22095 DATA HANDLING SYSTEM FOR SONIC AND/OR MAGNETOSTRICTIVE READOUT OF SPARK CHAMBERS. Bairstow, R.; Cawthraw, M. J. (Rutherford High Energy Lab., Chilton, Eng.). pp 166-73 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The system described was designed to enable determination of the kinematics of particle interactions by means of spark chambers. The spark, which is a flow of current, creates light and sound, and its position may be determined by means of any of these three properties. A typical sonic chamber has four strip microphones, one along each side of the chamber. By measuring the time of transit of the sound waves to the microphones the position of the spark may be determined. A typical magnetostrictive chamber has one plate replaced by a large number of fine wires about 1mm apart to form a plane. The wires all cross another single perpendicular wire, or line, with magnetostrictive properties. The spark current travels down the nearest wire and the resultant magnetic field creates a magnetostrictive shock wave in the perpendicular line. By measuring the time of transit of the shock wave down the magnetostrictive line, the position of the spark may be determined. The chambers have two wire-planes perpendicular to each other to uniquely determine a particle's position. A magnetostrictive chamber can handle several particles per event and as a result several pulses are produced by the transducer. The readout systems for both types of chamber use the same principle. On receipt of a Start signal each scaler receives a train of clock pulses, typically 4 MHz for sonic, at 20 MHz for magnetostrictive operation. The microphone pulse, or alternatively one of the pulses from the magnetostrictive transducer, produces a Stop pulse and terminates the supply of clock pulses. The final count in the scaler is a measure of time and one coordinate of the spark may be determined. The heart of the system is a bank of 16 bit, 20 MHz scalers driven by either a Sonic/Scaler Interface Unit, consisting of an assembly of Rutherford Laboratory Miniature Logic cards for sonic, or a Timing Channel Selector unit for magnetostrictive use. Up to 128 scalers, or channels of information, may be catered for in a standard system. Four of these scalers, together with their address decoding and readout logic, on to a data highway, are mounted on a double sided plug-in printed circuit board using plated through holes. (auth) (UK)

22096 SPIRAL READER ELECTRONIC EQUIPMENT (Engineering Materials). (California Univ., Berkeley. Lawrence Radiation Lab.). (CAPE-1573).

215 drawings.

The Spiral Reader is a high-speed measuring projector designed to measure 72 or 25 in. bubble chamber film. The control element of the Spiral Reader System is the Digital Equipment Corp. PDP-4 computer. The computer allows versatility in operating sequence permitting almost any change in the measuring procedures or in the input-output format. It also allows instantaneous feedback of the measured data, and shortens the delay encountered in the detection of hardware breakdown. Each element of the system is logically independent of all other elements of the system except the computer. The electronic drawings describe nonstandard input-output devices which are specifically for the system and which include: the x,y stage system, film drive system, periscope system, auto fiducial detection system, channel Q (data input), pulse analysis system, flying spot digitizer, console control system, and the theta system. (For details see TID-4100 Suppl. 52) (see also 20: 14861 and 22: 30859). (F.S.)

22097 LARGE BUBBLE CHAMBERS OF THE WORLD. Musset, Paul (Ecole Polytechnique, Paris). Nucleus (Paris), 9: 369-77(1968). (In French).

The place of bubble chamber studies in basic research is discussed, and the aims of research on fundamental particles are considered. Also, the principle of operation of bubble chambers is outlined, and hydrogen bubble chambers and the heavy liquid bubble chambers are described. (J.S.R.)

Radiation Dosimeters

22098 (AHSB(RP)R-89) PERSONAL BETA CONTAMINATION MONITORING. Report by a Working Party of the Health Physics Co-ordinating Committee. White, D. F. (ed.) (United Kingdom Atomic Energy Authority, Harwell (England). Authority Health and Safety Branch). Nov. 1968. 19p. Dep. CFSTI. UK 3s.

A study was made of the rationale of monitoring procedures for surface beta/gamma contamination on personnel. After consideration of the significance of personal contamination, monitoring procedures for the routine control of such contamination are recommended, together with statistical checks on their efficiency. Recommendations are also made on the instrumentation required. In particular, an instrument of the doorpost monitor type is considered to have a useful role to fulfil in personal contamination control. (auth)

22099 ENERGY DEPENDENCE OF LITHIUM FLUORIDE DOSEMETERS AT ELECTRON ENERGIES FROM 10 TO 35 MeV. Binks, C. (St. Lukes' Hospital, Guildford, Eng.). Phys. Med. Biol., 14: 327-8(Apr. 1969).

It was reported that the sensitivity of Type 7 LiF phosphor to high energy electrons is less than that to ^{60}Co radiation, and that there is a gradual fall in sensitivity with increase of electron energy. Measurements are described in which LiF phosphor (Con-Rad Type N and Type 7) was exposed to ~100 R from a ^{60}Co teletherapy unit and from a betatron producing electrons in the range 10 to 35 MeV. The results confirm that LiF is 10 to 12% less sensitive to high energy electrons than to ^{60}Co radiation, but there appeared to be no significant energy dependence in the range 10 to 35 MeV. (UK)

22100 CALIBRATION OF FARMER-BALDWIN DOSEMETERS BY CHEMICAL DOSIMETRY. Day, M. J.; Rasoul, M. (General Hospital, Newcastle-upon-Tyne, Eng.). Phys. Med. Biol., 14: 283-91(Apr. 1969).

C_λ (the quotient of the absorbed dose sensitivity for any radiation quality and the exposure sensitivity for 2-MeV x-rays) was determined for a Farmer–Baldwin dosimeter by chemical dosimetry combined with a 2-MeV exposure calibration by the National

Physical Laboratory. The radiation qualities were ^{137}Cs and ^{60}Co γ-rays and 4-MeV x-rays. The dosimeter was subsequently used to calibrate nine other ionization chamber instruments. The C_λ values were in the range 0.94 to 0.97, in reasonable agreement with expectation. (auth)

22101 RADIATION DETECTION WITH NON-SILVER HALIDE FILM. Iida, Hiroyoshi (National Inst. of Radiological Sciences, Chiba, Japan); Koshijima, Tokusaburo; Takahara, Hikaru. J. Nucl. Sci. Technol. (Tokyo), 6: 159(Mar. 1969).

The sensitivity of the non-silver halide Kalvar film for x- and gamma-ray dosimetry. It was found that x-ray exposures ranging from 0 to 200R failed to register detectable densities, and gamma-ray detectable density difference could barely be obtained even with intensifying screens with exposures from 0 to 10^6 R. (W.H.K.)

22102 UNIFORMITY OF HIGH-ENERGY ELECTRON-BEAM CALIBRATIONS. Ehrlich, Margarete; Lamperti, P. J. (National Bureau of Standards, Washington, D. C.). Phys. Med. Biol., 14: 305-14(Apr. 1969).

A survey is made of the first year of operation of a new service offered by the National Bureau of Standards. Dosemeter units, consisting of polystyrene blocks holding stoppered quartz spectrophotometer cells filled with Fricke solution, are being shipped periodically to groups requesting assistance with absorbed-dose measurements in high-energy electron beams. As a check on their stability, all dosemeters are pre-exposed to ^{60}Co γ-rays. The participants irradiate some of the dosemeters with electrons, using energies between about 5 and 50 MeV, and doses between 4000 and 8000 rads in water. The exposed dosemeters are returned to NBS for evaluation. During the first year of operation slightly more than one-half of the doses reported by the participants were within ±5% of the NBS dose interpretation, but some differed by as much as 30% or more. Little correlation was found between a participant's method of beam calibration and agreement with NBS dose interpretation. (auth)

22103 WIDE RANGE PERSONNEL NEUTRON DOSIMETER BASED ON A PROPORTIONAL COUNTER. Delafield, H. J. (United Kingdom Atomic Energy Authority, Harwell, Eng); Sparke, W. G.; Yoshida, Y.; Loosemore, W. R.; Dennis, J. A. pp 223-8 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

At present two forms of neutron dosimeter for personnel are in use, the nuclear track plate for fast neutrons and the cadmium-covered x-ray film for thermal neutrons. The nuclear emulsion will not detect neutrons below a theoretical threshold of 300 keV, which becomes nearer 500 keV in practice. Both types of conventional dosimeter can be used to measure the dose-equivalent from neutrons below 10 keV by utilising the reflection from the human body. Both dosimeters are therefore insensitive to neutrons in the energy range 10 to 500 keV. Neutrons in this intermediate energy range have been shown to contribute very significantly to the dose in the neighbourhood of power reactors, especially at the charge-discharge faces. Elaborate surveys are therefore necessary and the results from the existing dosimeters must then be extrapolated into energy regions where they are insensitive. A personnel neutron dosimeter is being developed not only to fill this gap, but also to have a response to neutrons over the entire energy range of interest and with good discrimination against gamma radiation. The dosimeter takes the form of a proportional counter with associated miniaturised electronics. (auth) (UK)

22104 MEASUREMENT OF ABSORBED DOSE AT A BONE-TISSUE INTERFACE BY MEANS OF A VACUUM CHAMBER. Burlin, T. E.; Hancock, B. W. (Polytechnic, London). pp 198-205 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The determination of the absorbed dose to living cells within irradiated bone presents some of the most difficult problems in radiation dosimetry. Two categories of dose specification are required; (1) the mean dose to soft tissue inclusions within bone, e.g., the mean dose to the whole trabecular marrow, is the significant parameter in relation to the induction of leukaemia; and (2) the dose to cells very close to a mineralised bone surface, e.g., the dose to cells lying near but not on the endosteal surfaces, is the significant parameter in relation to the induction of osteogenic tumours. Theoretical calculations have been undertaken on both cases, but experimental work has been mainly on the first case. No experimental measurement of the dose to a 30Å layer at a bone tissue interface has been reported. This paper describes a technique for making such measurements by means of a vacuum chamber. The current in a vacuum chamber results from the emission of very low energy electrons from a surface layer of the electrodes about 100Å thick, and is proportional to the absorbed dose in this surface layer. When the two electrodes of a vacuum chamber are constructed of different materials, the number of low energy electrons emitted provides a measure of the absorbed dose in the surface layer of the one material when it is irradiated in juxtaposition to second material. When the electrodes are constructed of bone-equivalent and tissue-equivalent materials, the dose to cells close to the surface on mineral bone can be measured. (auth) (UK)

Radiometric Instruments

Refer also to abstract 22033.

22105 A FUNDAMENTAL STUDY ON INDUSTRIAL MEASUREMENTS BY MEANS OF BACKSCATTERED GAMMA-RAYS. PART 2. MEASUREMENT OF LEVEL WITH COLLIMATED GAMMA-RAYS. Shibata, Keizo; Wakabayashi, Nobuo; Fujii, Mizuhiko; Ueda, Katsuhiko (Kobe Univ., Japan). Radioisotopes (Tokyo), 18: 130-6(Apr. 1969). (In Japanese).

The collimated gamma-rays from 0.1 Ci of ^{137}Cs entered the steel wall of a vessel containing water, and the backscattered rays were measured with a NaI(Tl) scintillation detector and a counting circuit. The scattered rays from the wall were interrupted by a detector-collimator or a small lead block. The results can be evaluated in terms of the necessary minimum value of (QT), or the product of the activity of the source Q and the time constant of the rate-meter circuit T. The value, which is derived from the limit at which it ceases by reason of the statistical fluctuation to be possible to distinguish between the counting rates with and without contents in the vessel, is calculated. From comparison of the values, it is found that the method using the small lead block is most effective in shielding the scattered rays from the vessel wall, and therefore best suited for level-gages. These results may be applied to density-meters, also. (auth)

22106 THE USE OF RADIOISOTOPES IN BEARING DEVELOPMENT. Salt, D. (Rolls-Royce, Ltd., Derby, Eng.). pp 18-24 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

A technique is described by which bearing slip can be measured without modifications to the engine. In the technique described the only modification is to include one of the balls or rollers of radioactive material (less than 10 millicurie of ^{59}Fe is sufficient for most applications) or to insert a small radioactive seed into the bearing cage. The principle behind this technique is simply the inverse square law. A detector is placed outside the engine (where it is easily shielded from vibration and thermal shock), and the distance from source to detector varies as the former rotates around the shaft. This causes the count rate to fluctuate above and below the mean rate and the effect is enhanced by absorption of the gamma rays by the material of the shaft. Results have been satisfactorily obtained with the detector four feet away from a six inch diameter bearing, and plans are being made to use even larger separations where required. (B.G.D.)

22107 CENTRIFUGAL SEDIMENTOMETER FOR PARTICLE SIZE ANALYSIS. Hardwick, W. H.; Laundy, B. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 1-9 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The need to measure and control the size of powders has prompted the industry to develop several methods of analysis, most of which make use of radioactivity in one way or another. The most useful techniques are based on sedimentation. A major problem is how to make the measurements while causing the minimum of disturbance to the system. It is here that the use of radioactivity has obvious advantages. Most of the early radiometric methods made use of tracers which enabled very small quantities of material to be used for an analysis, thus minimising flocculation and hindered settling problems. But since the radioactivity must be induced in the sample, these methods depend upon the availability of a suitable source of neutron irradiation and the suitability and purity of the isotopes produced on irradiation. Methods using an external source do not have these disadvantages and the β-backscatter thickness measurement technique has been applied to particle size analysis with great success for many years. The equipment used is a Perspex centrifuge tube with a thin flat base (0.4 mm thick) situated above a 3 mCi ^{90}Sr–^{90}Y source, and a scintillation counter. The counter consists of a 45 mm diameter disc of organic plastic scintillator, coupled to a photomultiplier, the count rate being fed to a strip chart recorder. A slurry of the sample dispersed in a suitable fluid is placed in the tube, in position above the counter, and held in homogeneous suspension by stirring. On removal of the stirrer, sedimentation proceeds and as the deposit builds up on the bottom of the tube the count rate increases and a cumulative sedimentation curve is obtained on the recorder chart. The particle size distribution is computed from this curve by the method of Oden. Recent improvements, resulting in a wider range of applicability, involve the use of an ion chamber and a backing off procedure to improve the counting statistics and sensitivity. (auth) (UK)

22108 MOISTURE MEASUREMENT BY NEUTRONS. Sakaki, Masamichi (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Int. Ed., No. 40, 31-7(Jan.-Feb. 1969).

Neutron moisture meters based on the use of fast neutrons whose slow-down is chiefly due to hydrogen atoms are attracting attention as epoch-making moisture measuring instruments that can make continuous measurements of moisture, thereby enabling the automatic control of a process. Presently these meters are finding wide application in Japan, mainly for steel-making, public works, glass-making, casting and paper-making. There are many merits inherent in the neutron moisture meter: the possibility of continuous moisture measurement; the ease of incorporating it into automatic process control, with the output being an electric signal; a large effective volume of moisture measurement; and the possibility of being included as an on-line instrument, depending on the construction of the probe, even for a process under unfavorable ambient conditions. (auth)

22109 SLOW NEUTRON DETECTOR OF ^{243}Am. Allen, Linus S. Jr. (to Mobil Oil Corp.). U. S. Patent 3,435,218. Mar. 25, 1969. Filed June 30, 1965.

A slow neutron detector for use in pulsed neutron logging operations is described. The detector comprises a slow neutron absorber of americium-243 and a gamma ray detector positioned in close proximity to the absorber to detect gamma rays emitted by the absorber upon the capture of neutrons. In addition, an epithermal neutron absorber of indium is disclosed as positioned in close proximity to the gamma ray detector whereby slow neutrons and epithermal neutrons may be detected and distinguished on a time basis. In the embodiment disclosed, the two absorbers are sandwiched between two gamma ray detectors. These detectors are coupled to a common coincident circuit whereby gamma rays emitted from the absorbers may be distinguished from extraneous gamma rays. (Offic. Gaz.)

22110 PULSED NEUTRON WELL LOGGING TECHNIQUE AND SYSTEM. Givens, Wyatt W. (to Mobil Oil Corp.). U. S. Patent 3,435,216. Mar. 25, 1969. Filed Sept. 15, 1965.

A pulsed neutron well logging technique and system are described for simultaneously producing continuous logs of thermal neutrons and thermal neutron capture gamma rays, each detected within a time window occurring at a time following each neutron burst whereby the thermal neutrons and thermal neutron capture gamma rays detected are indicative predominantly of formation characteristics. By recording only the higher energy gamma rays detected, the gamma-ray log is made selectively sensitive to chlorine but insensitive to elements in shale, such as boron. The thermal neutron log obtained is sensitive to the total absorption cross section. Preferably, a source is employed which produces a substantially constant number of fast neutrons per burst. (Offic. Gaz.)

22111 DOWNHOLE SYSTEM FOR STORING AND READING OUT DETECTOR SIGNALS FOR TRANSMISSION TO THE SURFACE AT RELATIVELY LOW FREQUENCY. Zemanek, Joseph Jr. (to Mobil Oil Corp.). U. S. Patent 3,435,224. Mar. 25, 1969. Filed June 23, 1965.

A well logging signal storage and readout system in a pulsed neutron logging tool having a pulsed neutron source and a radiation detector is described. The storage system comprises two storage circuits for storing detector pulses produced upon detection of radiation during two time periods within each cycle of operation. Means is coupled to each storage circuit for generating timing pulses at a relatively low frequency for reading out, at the low frequency, pulses stored in each storage circuit for application to a transmission line for transmission to the surface. (Offic. Gaz.)

22112 CALIBRATION OF GAMMA RAY RADIOACTIVE BOREHOLE LOGGING TOOLS. Pritchett, William C. (to Atlantic Richfield Co.). U. S. Patent 3,435,215. Mar. 25, 1969. Filed June 6, 1967.

The calibration of borehole logging tools having a gamma detector is described. The calibration apparatus includes a neutron source; a target composed of neutron capture material; a housing composed of neutron moderating material; connecting means for attaching the housing to the logging tool; a chamber formed in the housing for the source; and a cavity formed between the connecting means and the chamber for the target. Neutrons generated by the source are moderated in the housing to thermal energies and bombard the target. Gammas emitted by the target responsive to the thermalized neutrons are detected by the gamma detector in the tool. (Offic. Gaz.)

22113 DUAL CHANNEL RADIATION GAUGE FOR IDENTIFYING MATERIAL COMPONENTS. Hanken, Albert F. (to Industrial Nucleonics Corp.). U. S. Patent 3,435,220. Mar. 25, 1969. Filed Feb. 26, 1965.

A gage for determining the presence and the weight of an element in a mixture by measuring the radiation transmitted through the material from a bremsstrahlung source in two energy bands is described. An energy band is established on either side of the K-edge energy of the element to be identified by two pairs of Ross filters. A pair of detectors provide signals proportional to the amount of radiation transmitted in the energy bands. The ratio of one signal to the other is computed to compare the relative absorption in each of the two energy bands. (Offic. Gaz.)

Miscellaneous Instruments and Components

Refer also to abstracts 21839, 21985, 21989, 22003, 22033, 22455, 23256, 23841, 23935, and 24038.

22114 (CGS-C-106) U. S. COAST AND GEODETIC SURVEY SEISMOGRAPH SYSTEMS. Navarro, Richard; King, Kenneth W. (Coast and Geodetic Survey, Las Vegas, Nev. Special Projects Party). June 1967. 145p. Dep. CFSTI.

The Special Projects Party of the Coast and Geodetic Survey has used many types of seismograph systems in its participation in nuclear and high explosive tests since 1949, both on and off-site of the Nevada Test Site. This participation has included ground motion measurements, vibration studies, and background and earthquake monitoring. All the seismograph systems presently utilized by Coast Survey in accomplishing its objectives to the Nevada Operations Office of the Atomic Energy Commission and other users in the nuclear and high explosive testing program are described. Also, the procedure used to calibrate each system is described. (auth)

22115 (LA-3955) ANALYTICAL METHOD FOR MASS SPECTROMETER LEAK DETECTION. Winkelman, Claude R.; Wilson, Norman G. (Los Alamos Scientific Lab., N. Mex.). June 1968. Contract W-7405-eng-36. 10p. Dep. CFSTI.

A method is presented for using a mass spectrometer leak detector analytically for large systems. The method consists of calibrating the mass spectrometer, measuring the response time of the system being checked for leaks, and then utilizing these results in the system tests. The method has been used to measure leaks in two large (360 and 600 liters) heat exchangers of complex internal geometry. The response times of these vessels were 18 and 24 min, respectively, and the minimum detectable leak was about 4.6×10^{-10} std-cc/sec for each vessel. (auth)

22116 (LA-4082) DESIGN OF A SOLENOID FOR A LAMB-SHIFT POLARIZED-ION SOURCE. Ohlsen, Gerald G.; Jackson, Jasper A.; McKibben, Joseph L.; Lawrence George P. (Los Alamos Scientific Lab., N. Mex.). Jan. 2, 1969. Contract W-7405-eng-36. 23p. Dep. CFSTI.

The magnetic field requirements for the nuclear spin filter of a Lamb-shift source of polarized negative ions are described. Magnetic design and performance details for the Los Alamos Scientific Laboratory source are given. The main component is a solenoid with good homogeneity (~0.03%) over a 10-in. length and with a field that falls to low values about 12 in. from each end of the homogeneous region. (auth)

22117 SHORT DEAD TIME GATED INTEGRATOR. Visentin, R. (CNEN, Frascati, Italy). Nucl. Instrum. Methods, 69: 357-8(Apr. 1969).

A fast gated dc integrator is described which accepts input pulses of any shape and amplitude from 0.1 to 100 mA. It has been tested at frequencies up to 12 MHz. When used as a linear gate it operates at higher frequencies up to 20 or 25 MHz. (auth)

22118 DIGITAL SPECTRUM STABILIZER FOR FAST ANALOG-TO-DIGITAL CONVERTER. Tharun, U. (Univ., Mainz). Nucl. Instrum. Methods, 69: 335-7(Apr. 1969). (In German).

A versatile spectrum stabilizer is described, suitable for all ADC's with a digital parallel output and a pilot pulse at the end of the conversion. The stabilizer is especially developed for a 100 MHz ADC, but it is independent of the digitizing rate and the mode of conversion. The unit has a maximum cyclus time of 2 μsec and permits a parallel transfer rate of 500 kHz. The stabilizer corrects the effects of gain drift and is insensitive to statistical errors. (auth)

22119 TWO SIMPLE METHODS OF RAMP GENERATION AS APPLIED TO PULSE-HEIGHT ANALYSER LINEARITY MEASUREMENTS. Walker, D. A. S. (Forskningsinstitutet foer Atomfysik, Stockholm). Nucl. Instrum. Methods, 69: 341-3 (Apr. 1969).

Two simple and economical systems for measuring the differential linearity of multi-channel pulse-height analysers are described. Bipolar and unipolar ramps, generated by operational amplifiers, are fed to a standard Hg-relay pulse generator to modulate its output. General considerations and limitations of the rate-of-rise of the generated ramps are briefly discussed. (auth)

22120 A TIME-TO-AMPLITUDE CONVERTER OF SIMPLE CONSTRUCTION. Ogata, A.; Tao, S. J. (New England Inst., Inc., Ridgefield, Conn.). Nucl. Instrum. Methods, 69: 344-6 (Apr. 1969).

A very simple time-to-amplitude converter system based on crossover timing is described. It gives a resolution of a fwhm of 300 ps when the dynamic range of the spectrum of ^{60}Co γ-rays is set to greater than 6 dB. Thus, it is very useful in the measurement of positron annihilation lifetimes. (auth)

22121 TESTING THE LINEARITY OF TIME-TO-AMPLITUDE CONVERTERS. Camhy-val, C.; Dreux, M.; Dumont, A. M.; Marchal, J. (CNRS, Paris). Nucl. Instrum. Methods, 70: 25-8(Apr. 1, 1969). (In French).

A method of testing time-to-amplitude converters (TAC) is described using a random time spectrum. The experimental variance of the spectrum is compared with the theoretical variance. A method is developed for correcting the linearity. The results of the linearity test are presented. (auth)

22122 FAST RANDOM PULSE GENERATOR. Passeneau, J. (CEN, Grenoble, France). Nucl. Instrum. Methods, 70: 29-35 (Apr. 1, 1969). (In French).

This generator uses pile-up statistics of photoelectrons emitted by the cathode of a photomultiplier tube, which is weakly lighted by a grid controlled tuning indicator. Pulses mean rate at the output of a fast amplitude discriminator is variable from 1 kHz to 25 MHz; this mean rate is moreover controlled, from 0.25 MHz to 25 MHz, by comparing a reference voltage with the voltage provided by a logarithmic ratemeter. The time distribution of such pulses is a Poisson distribution, as it is verified by an experimental device allowing to study the time interval distribution between two successive pulses. (auth)

22123 NOISE-SIGNAL PICKUP IN COAXIAL CABLES. Brookshier, W. K. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 70: 1-10(Apr. 1, 1969).

Three mechanisms by which undesired signals may appear across a load at the end of a coaxial cable are identified and discussed. These three mechanisms extend beyond the normal shielding action of the outer conductor against electric and magnetic fields, and account for a large fraction of the pickup problems encountered in the use of coaxial cables. The first mechanism involves the flow of an externally-induced unbalance current through the outer conductor, and the resulting response across the load. The second and third mechanisms involve end effects which occur in the sending and receiving-end circuits beyond the extent of the coaxial structure. Experimental methods are presented for the measurement of the noise signal components from each of the three mechanisms. Techniques for minimizing the magnitudes of the pickup signals are also suggested. (auth)

22124 WIDE DYNAMIC RANGE LOGARITHMIC COUNT RATE METER. Sheen, E. M.; Weddle, R. C. (Battelle-Northwest, Richland, Wash.). Nucl. Instrum. Methods, 70: 41-4 (Apr. 1, 1969).

The developed solid state, logarithmic, count ratemeter, having eight decades of dynamic range (10^1 to 10^8 counts/min) and applicable in fast nuclear counting systems, incorporates a high-speed integrated circuit binary chain and provides a maximum deviation of ±16% of reading from the desired logarithmic characteristic over the entire range of the instrument. (auth)

22125 CHARGE PREAMPLIFIER. Letourneau, R.; Passerieux, J. P.; Quidort, J. (CEN, Saclay, France). Nucl. Instrum. Methods, 70: 106(Apr. 1, 1969). (In French).

The described charge sensitive preamplifier allows the use of high capacity silicon junctions (100 pF and more) retaining in the same time the qualities of a low electronic noise and a fast rise time. The dc coupling between the input and the output and the allowed maximum output amplitudes ±10 V (with 100 Ω) permit a high counting rate without loss of linearity. (auth)

22126 ELECTROSTATIC SWEEP SYSTEM FOR PERFORMING UNIFORM ION BOMBARDMENTS WITH AN ISOTOPE SEPARATOR. Walker, D. A. S. (Research Inst. for Physics, Stockholm). Nucl. Instrum. Methods, 70: 123-4(Apr. 1, 1969).

A simple and reliable system for producing up to 30 mm of linear deflection for 40 keV ions is described. A triangular waveform connected to the electrostatic stabilizer plates of an isotope separator is used to sweep the beam across a target. (auth)

22127 TENTATIVE ELECTRONICS WITH INTEGRATED CIRCUIT ELEMENTS FOR NUCLEAR PHYSICS EXPERIMENTS. Coli, M.; Zallo, A. (CNEN, Frascati, Italy). Nucl. Instrum. Methods, 70: 115-18(Apr. 1, 1969).

The use of conventional elements of the integrated circuit TTL families is analyzed with regard to the problem of resolving time and operating frequency for nuclear physics experiments. Quantitative results to evaluate the differential and integral resolving time and the maximum operating frequency were reported. A low cost special purpose electronics seems to be realistic for multichannel on-line experiments. A neutral event detection in an η-meson photoproduction experiment is given as an example. (auth)

22128 USE OF A TIME-SHARING COMPUTER IN NUCLEAR CHEMISTRY. Fryklund, J.; Loveland, W. (Oregon State Univ., Corvallis). IBM J. Res. Develop., 13: 75-8(Jan. 1969).

The Oregon State University computer analyzer system couples the advantages of the on-line data acquisition and analysis with the low cost of time-sharing computer. The system operates in two modes. In Mode A, a 4096-channel analyzer serves as a data acquisition and buffer storage device with the contents of the analyzer memory being transmitted via telephone lines to the Oregon State University computer for analysis. In Mode B, the correlated outputs of N analog-to-digital converters (corresponding to an N-parameter event) are transmitted to the computer in real time for storage and analysis. Additional information, programming, and computations may be entered at any time from a remote terminal console. The results of the data analysis can be returned immediately to the remote terminal console or to any regular computer output device. This system has the advantages of being able to utilize the full facilities of a large computer, its FORTRAN compiler, etc., for on-line data acquisition and analysis while avoiding the responsibilities of hardware maintenance and systems programming for the nuclear chemists. (auth)

22129 CAMAC: A EUROPEAN STANDARD SPECIFICATION FOR MODULAR INTERFACE UNITS BETWEEN NUCLEAR EXPERIMENTS AND DATA PROCESSING EQUIPMENT. Nucl. Eng. Int., 14: 345-7(Apr. 1969).

The development of the CAMAC system, as agreed by the Esone Committee, is reviewed. Illustrations are given of the standard CAMAC module, showing dimensions, and of the adaptor unit for use with the American NIM system with which CAMAC is basically compatible. Procedure during a dataway operation is described. (UK)

22130 PULSE COUNTING METHOD IN MASS SPECTROMETRY. Otsuji, Tomoo; Miyake, Hiroshi (Kobe Univ. of Mercantile Marine, Japan). Shitsuryo Bunseki, 17: 496-9(Mar. 1969). (In Japanese).

It was attempted to obtain mass spectra in a pulse counting mode with a continuous channel electron multiplier. Two continuous channel electron multipliers were used. One of them had a length of about 100 mm, inside diameter of 1.5 mm and arc of 270°. The resistance was about 2 × 10^8 Ω. Background rate was 0.2 cps at an applied voltage of 3.0 kV, 0.04 cps at 2.8 kV and 0.002 cps at 2.6 kV. When argon ions were injected with an accelerating voltage of 1 kV, counting rate attained a plateau above 2.3 kV, and its slope was 1.2%/100 V. Pulse height distribution at 3.0 kV showed saturation. The other electron multiplier which had length of about 84 mm, inside diameter of 1 mm, arc of 480° and resistance of about 1.5 × 10^8 Ω, was mounted on a 90° magnetic deflection type mass spectrometer with 100 mm radius of curvature. Characteristics of this multiplier were studied and mass spectra of residual gas were obtained. This multiplier had a background rate of 2 to 3 cps at 2.4 kV. Mass spectra obtained with a 12 stage Cu–Be electron multiplier in the pulse counting mode were also investigated. (auth) (NSA of Japan)

22131 SMALL COMPUTER-BASED EXPERIMENTAL EQUIPMENT IN MATERIALS PHYSICS DIVISION, A.E.R.E. Hall, J. W.; Turberfield, K. C. (Atomic Energy Research Establishment, Harwell, Eng.). pp 113-19 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The potential of small computer systems is shown to allow the employment of new techniques in data collection and reduction, and the provision of enhanced access facilities enabling experimenters to inspect and assess their data more readily. This degree of flexibility would be uneconomic in more purpose-built equipment. (auth) (UK)

22132 LOW LEVEL DIRECT CURRENT AMPLIFIERS. Fowler, E. P. pp 85-95 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

A description is given of developments in designs of, and in semiconductor devices used in, low level direct current amplifiers for nucleonic instruments. They are primarily intended for use with high impedance current sources (ionisation chambers), but many of the design features also apply to other situations when low impedance or voltage measurements may be required. (auth) (UK)

22133 TRANSPORTABLE SPECTROMETER AND COLLIMATING SYSTEM FOR X-RAY SPECTROMETRY. Peaple, L. H. J.; Burt, A. K.; Gibson, J. A. B. (Atomic Energy Research Establishment, Harwell, Eng.). pp 192-7 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The techniques developed by Peaple and Burt have been applied to the measurement of photon spectra used in x-ray dosimetry (exposure rates from 0.01 to 100 mR min^{-1} at energies from 20 to 200 keV). The transportable spectrometer and collimating system are described and the conversion of the pulse height distribution into a photon spectrum is briefly discussed. The application of the method to diagnostic sets is also considered. (auth) (UK)

22134 THE USE OF DIGITAL TECHNIQUES TO CONTROL SPEED AND PHASE OF THE HIGH SPEED ROTORS OF A NEUTRON TIME-OF-FLIGHT SPECTROMETER. Russell, M. C. B.; Smith, D. B. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 186-91 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

This paper describes electronic methods used to control rotation of the neutron shutters which form part of the Harwell Chopper—a neutron time-of-flight spectrometer. The shutters normally rotate at speeds from 100 to 700 revs/sec. It is common practice to drive two rotors at the same speed, or at harmonic speeds, and with a precise phase relationship which is related to the neutron flight path between them. Those neutrons which go through the slots in both rotors may then emerge as a monokinetic pulsed source. For some experiments up to five rotors are driven at synchronous speeds. The absolute speed of rotors need not be very precise, and the required phase relationship between rotors, which may have to be maintained within a few minutes of arc during an experiment for several days, can be achieved by correcting the speed of one rotor to keep it aligned with the phase of another. Such methods have proved particularly successful when only two rotors are used which have similar characteristics. This method, however, has been abandoned because its success depended on a similarity of the electro-mechanical parameters of each rotor assembly. The new method, an independent drive for each rotor may be used to control the phase of many rotors of different inertia turning at different speeds and locked in phase to reference pulses repeated at the lowest common multiple frequency. The essential elements developed for digital control of a rotor are described. (auth) (UK)

22135 A 4096 CHANNEL ANALYSER. Hickman, S. A. (EMI Electronics, Wells, Eng.); Prior, G. M.; Lewis, J. pp 182-5 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

A discussion is presented of the design philosophy of large multichannel analysers, and it is shown how the features of the design were determined by the current state of component technology and the present trends in experimental procedure. A brief description of the 4096 analyser is included. (auth) (UK)

22136 THE FEASIBILITY OF USING M.O.S. INTEGRATED CIRCUITS IN REACTOR SAFETY SYSTEMS. Whyard, R. E. (Atomic Energy Establishment, Winfrith, Eng.); Evans, J. D.; Ellis, R. M. pp 96-103 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

In order to achieve a satisfactory compromise between safety and availability in the operation of nuclear reactors it is usual to employ redundancy in the instrumentation, the decision-making logic and the control or shut-down devices which together comprise the protection system. The type of logic conventionally employed to make majority-vote decisions suffers from the inherent disadvantage that it cannot respond to the removal of a minority of inputs. Straightforward overall proof testing of the instruments and associated logic, in order to reveal unsafe failures, is therefore impossible without interfering with the logic circuits involved. Also, since safe failures in voting circuits can remain undetected the probability of causing a spurious trip when testing an instrument can be uncomfortably high. The difficulty of applying adequate proof-tests, particularly in plants operating continuously for long periods, has encouraged the development of logic elements which must have a strongly preferential mode of failure, in the interests of safety, coupled with a sufficiently low overall failure rate to achieve acceptable plant availability. For this kind of application magnetic core logic elements have been favoured. A novel approach in which the required integrity is obtained in the logic circuits by the use of automatic through testing applied much more frequently than has previously been possible, to the point where either safe or unsafe logic failures are almost immediately revealed is discussed. As a result, the integrity of the logic system may be maintained at a desired level by executing prompt repairs when necessary. Bipolar or metal oxide-silicon (MOS) transistors are employed. (auth) (UK)

22137 AN ADVANCED MODULAR SYSTEM OF NUCLEAR ELECTRONICS FOR ON-LINE COMPUTER APPLICATIONS. Bisby, H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 128-31 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

Representatives from major nuclear laboratories in Europe have collaborated, under the title of the ESONE Committee, in defining a standard physical form and other basic features for a new modular unit system of electronic instrumentation. The design of this system anticipates the inevitable future prominence of integrated circuit components. It further takes into account the current trend, in scientific work, towards the real-time association of transducers with computers or other data processors for the collection, display and analysis of measurement data and for the purpose of control. The design principles which have evolved from the ESONE Committee and its two Working Groups are described and an interpretation of the role which equipments designed to the new standard could play is given. The Harwell 7000 Series of equipments conforms with this new System. (auth) (UK)

22138 DEMOUNTABLE INDUCTION HEATER POWER-LEAD COUPLING FOR USE IN ULTRAHIGH VACUUM. Danielson, P. M. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 40: 736-7(May 1969).

The design of a coupling, based on that of a conventional flare-type fitting, for use within a baked (250°C) uhv system at pressures $<10^{-10}$ torr is described. The coupling provides a leak-free uhv seal without excessive power losses and withstands high temperature bakeout without introducing contaminating gases. (C.E.S.)

22139 IMPULSE AMPLITUDE DISCRIMINATION CIRCUIT AND ITS APPLICATION TO SPONTANEOUS DISCHARGE ANALYSIS. Yamaura, Itsuo (Hokkaido Univ., Sapporo); Chichibu, Shiko. Tohoku J. Exp. Med., 93: 261-7(Nov. 7, 1967).

The effect of microwave irradiation (11 Gcps frequency and 100 μW/mm^3 power) on crayfish ganglionic discharge was determined by the use of a simple electronic device to discriminate amplitudes of action potentials. The principle of the pulse amplitude discrimination circuit (TADC) was to use the time lag in the falling phase of the action potential and the application of NOT-AND gate in the circuit. The microwave irradiation caused a biphasic change of impulse frequencies in the crustacean ganglion. When the record was taken directly with an ordinary ink-writer without IADC, it was difficult to detect the irradiation effect in every experiment. This was caused by the contamination of smaller pulses and by the insufficiency of the power to drive the galvanometer. When the same record was analyzed with IADC, the pulses for the high and middle levels were separately demonstrated. It is possible that the frequency changes observed were the result of the microwave irradiation on one nerve cell. (BBB)

22140 COLLIMATOR. Gennaro, Gianni (to EURATOM). British Patent 1,149,063. Apr. 16, 1969. Priority date Aug. 17, 1965, Italy.

The design of a lead collimator for use in radiodiagnosis and other fields is presented. The collimator is designed for easy handling and rapid adjustment. (W.H.K.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 23048 and 23279.

22141 (N-68-37750) STUDY OF RADIATION EFFECTS IN Li DOPED SILICON SOLAR CELLS. Quarterly Report. Carter, J. R.; Scott, R. E.; Downing, R. G. (TRW Systems Group, Redondo Beach, Calif.). Aug. 15, 1968. Contract JPL-952251. 13p. (NASA-CR-97321; TRW-10971-6005-R-0). CFSTI.

This report covers the initial three months of effort concerning radiation effects in Li-doped silicon. Initial efforts utilizing $LiAlH_4$ as a diffusion source are promising, but to date have failed to yield surface lithium concentrations in excess of 10^{17} atoms/cm^3. Lang x-ray topography has been attempted to determine whether lithium instabilities at higher temperatures are due to precipitation, outdiffusion, or some other mechanism. Results to date indicate that lithium precipitation producing strained regions greater than 0.1 mm are not observed. Removal rate studies indicate exponential carrier removal as a function of electron fluence in Li-doped float-zone silicon, but a linear dependence on electron fluence in crucible grown silicon. Finally, isochronal annealing studies indicate a variety of material dependent effects including relatively low temperature annealing stages and reverse annealing stages. Sufficient data on these annealing phenomena have not yet been obtained to determine their dependence on material parameters. (auth) (STAR)

22142 (N-68-37832) SOLAR CELL RADIATION DAMAGE ON SYNCHRONOUS SATELLITE ATS-1. Waddel, Ramond C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 1968. 22p. (NASA-TM-X-63379; X-710-68-408). CFSTI.

Various types of solar cells were monitored during 416.8 days in synchronous orbit on satellite ATS-1. Judging by the remaining percentage of initial maximum power qualified conclusions were: degradation was greater than expected; optimum base resistivity was 10 ohm-cm; optimum shield thickness was 6 mils; sapphire and silica shields were comparable; silica shields were superior to glass; boron and aluminum doping were comparable; and that it was necessary to presume some radiation damage, some drop in illumination, and a development of series resistance to account for the results. (auth) (STAR)

22143 (N-68-38209) EFFECTS OF UNIFORM DAMAGE TO SILICON SOLAR CELLS. Barrett, M. J.; Stroud, R. H. (Exotech, Inc., Washington, D. C.). Oct. 10, 1968. Contracts NAS7-100; JPL-952246. 30p. (NASA-CR-97418). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

A theoretical analysis of published data on silicon solar cells has been performed. Reasonable values of the photovoltaic current density at the cell junction have been obtained as a function of the minority carrier diffusion length L in the base region. The calculation was performed on a computer with a numerical technique which appears applicable to a nonuniform profile of L across the base region, as occurs after low-energy proton damage. The junction characteristics of the cells were also shown to be affected by radiation, light and temperature in ways that can be described by simple mathematical functions. (auth) (STAR)

22144 PERFORMANCE DETERIORATION OF SURFACE BARRIER DETECTORS BY FISSION FRAGMENT BOMBARDMENT. Shiraishi, F. (Rikkyo Univ., Yokosuka, Japan). Nucl. Instrum. Methods, 69: 316-22(Apr. 1969).

Performance deterioration of a surface barrier semiconductor detector due to radiation damage induced by fission fragments was investigated. An increase of reverse current, a decrease of pulseheight for incident particles, and a decrease of resolution power for spectroscopy were observed by the exposure to fission fragments. The increasing rates of the reverse current were 3.8×10^{-8} and 4.2×10^{-9} μA per fragment for applied biases of 30 and 60 V, respectively. The decreasing rates of the pulseheight for fission fragments from $^{235}U(n_{th},f)$ were 4.2×10^{-8} and 2.9×10^{-8}% per (fragment/cm^2) for the light group and 3.0×10^{-8} and 2.1×10^{-8}% per (fragment/cm^2) for the heavy group, at applied biases of 30 and 60 V, respectively. The decreasing rate for alpha particles of 6.11 MeV was about 1/15 of that for fission fragments. The field-dependent part of the pulseheight defect for fission fragments increases linearly and the field-independent part remains constant with the exposure dose of fission fragments. The pulseheight defects and the decrease in pulseheight due to irradiation are discussed with a model which takes into account the recombination loss of charge carriers on recombination centers during a plasma time. The experimental results can be reasonably explained by the model. (auth)

22145 EFFECTS OF GAMMA RADIATION ON TRANSISTORS. Shao, J. B.; Tang, M. D. (National Tsing Hua Univ., Hsinchu, Taiwan). Ho Tsu K'o Hsueh, 6: 21-38(Oct. 1968).

The effects of gamma radiation on transistors of various types and materials were studied. Gamma-rays from ^{60}Co were used to irradiate the transistors up to an integrated dose ϕ of 8.16×10^7R. The experimental results indicate that the inverse of the common emitter current gain of transistors increases linearly as a function of the integrated dose for a sufficient long exposure; NPN transistors decay more slowly than PNP transistors; and the high-frequency transistors are less sensitive to radiation. These experimental data agree reasonably well with the theoretical predictions. Also, a modified boundary value problem was used to solve the continuity equation in the base region of a transistor. The solution found can fit all the experimental results and include some of the formerly derived formulas as its special cases. (auth)

22146 SOME OBSERVATIONS OF RADIATION DAMAGE IN LITHIUM-DRIFTED SILICON DETECTORS IN NUCLEAR REACTION EXPERIMENTS. Goulding, F. S.; Lothrop, R. P. (Univ. of California, Berkeley). pp 337-8 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Observations of radiation damage in Si(Li) detectors are reported. Suggestions are made for precautionary measures to reduce fast neutron doses. (J.W.R.)

22147 EFFECTS PRODUCED BY FAST NEUTRON BOMBARDMENT OF GERMANIUM(LITHIUM) GAMMA-RAY DETECTORS. Kraner, H. W.; Chasman, C.; Jones, K. W. (Brookhaven National Lab., Upton, N. Y.). pp 339-61 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

A systematic study was made of the effects of fast neutron bombardment on Ge(Li) γ-ray detectors. Reverse leakage current, capacitance, resolution, and rise times were studied as a function of total neutron flux at 1.1, 5.8, and 16.5 MeV. Some work on the restoration of detectors after radiation damage is discussed. (J.W.R.)

22148 EXPERIMENTS ON GENERATION-RECOMBINATION NOISE IN GERMANIUM SINGLE CRYSTALS IRRADIATED WITH FAST NEUTRONS AND GAMMAS. Bilger, H. R. (Argonne National Lab., Ill.); McCarter, E. R. pp 160-6 of Semiconductor Nuclear-Particle Detectors and Circuits. Brown, W. L. (ed.). Washington, D. C., National Academy of Sciences, 1969.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn. See CONF-670520.

Generation-recombination noise in germanium crystals was measured for a ^{60}Co γ source and for 14.7-MeV neutrons. It was found radiation damage changed the parameters but not the shape of the spectra. The changes could be removed by annealing. (J.W.R.)

22149 STRESS EFFECT OF GOLD-DOPED AND GAMMA-IRRADIATED SCHOTTKY-BARRIER DIODES. Chino, Ken-ichi; Okamoto, Hiroshi; Ariyoshi, Hisashi; Mizushima, Yoshihiko (Nippon Telegraph and Telephone Public Corp., Tokyo). Jap. J. Appl. Phys., 8: 502-3(April 1968).

Results were obtained for the stress effect of a Schottky-Barrier diode containing a large density of generation-recombination centers introduced intentionally either by gold doping or by gamma irradiation, whereas the reference diode exhibited no observable stress sensitivity up to 10^9 dyne/cm^2. These results suggest the previous interpretation of the stress effects of a p-n junction containing generation-recombination centers is controversial and a new mechanism must be required for the stress sensitivity. (J.F.P.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 21754, 22247, 22248, 22250, 22270–22276, 22278, 22299, 22300, 22302, 22314, 22318–22320, 22348, 22362–22391, 22414, 22426, 22439, 22441, and 23946.

22150 (AEC-tr–6944) DISTRIBUTION AND BIOLOGICAL EFFECTS OF RADIOACTIVE ISOTOPES. Moskalev, Yu. I. Translation of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966. 727p. Dep. CFSTI.

A collection of papers is presented on various biological aspects of radioisotopes. The subject areas covered are the distribution of radioisotopes in animals, the effects of physiological and physicochemical factors on the distribution, the biological effects, the use of various agents to eliminate radioisotopes from animals, and the treatment of injuries induced by radioisotopes. Separate abstracts have been prepared for all 80 papers. (M.M.B.)

For abstracts of individual papers see: 22151–22183, 22247, 22248, 22250, 22270–22278, 22318–22321, 22362–22391, and 22439.

22151 (AEC-tr–6944, pp 7-13) DISTRIBUTION OF RADIOACTIVE ISOTOPES IN THE ORGANISM OF ANIMALS DEPENDING ON THE METHOD OF ADMINISTRATION. Panchenko, I. Ya.; Sarapul'tsev, I. A. Translated from pp 9-14 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The build-up and distribution of ^{89}Sr, ^{90}Sr, ^{90}Y, ^{91}Y, and ^{45}Ca were studied in cows, dogs, goats, and sheep as a function of the method of administration. Solutions of various concentrations were introduced intravenously, subcutaneously, and orally into the animals. Regardless of the route of administration the pattern of distribution of Sr and ^{45}Ca in organs and tissues was the same. The bulk of the isotopes was deposited in the skeletons. The distribution of Y differed from that of Sr in that in addition to deposits in the skeleton, large amounts were found in liver, kidney, mammary and salivary glands, pancreas, and lymph nodes. Marked differences were observed in the rates of elimination of Sr and Y from soft tissues, blood, and skeleton. Yttrium was eliminated more slowly than Sr. (M.M.B.)

22152 (AEC-tr–6944, pp 14-24) FEATURES OF THE DISTRIBUTION OF ^{90}Sr AND ^{144}Ce IN THE ORGANISM OF WHITE RATS WHEN INTRATRACHEALLY ADMINISTERED. Korolev, G. K. Translated from pp 14-22 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

In order to study the absorption of radioisotopes via the lungs chlorides of ^{90}Sr and ^{144}Ce (0.4 μCi per g) were administered intratracheally into rats. The rats were killed at various times over a period of 2 months and activity in the lungs, the gastrointestinal tract, the heart, the skin and the carcass was determined by the wet method following the calcining of these organs. Activity was calculated with the aid of a "B" type setup equipped with an end-window counter. The penetration of ^{90}Sr and ^{144}Ce into the respiratory organs was the most dangerous. The half-life of ^{90}Sr in the lungs was three days. After the first 24 hours as much as 80 percent of the introduced activity was found in the internal organs of the rat. The distribution of ^{90}Sr in the skeleton after intratracheal administration was much the same as after intravenous and intraperitoneal administration (in the first case 76 percent of the isotope accumulated after the first 24 hours in the rat skeleton and in the second and third cases — 80 percent). Cerium-144 was slowly absorbed from the lungs: its half-life in the respiratory organs was 16 days. The maximum amount of the absorbed radioactive isotope was 41% (on the sixth day after administration). Following its absorption the greatest amounts of ^{144}Ce were deposited in the liver (27.15%) and the skeleton (14.9%). (M.M.B.)

22153 (AEC-tr–6944, pp 25-34) DISTRIBUTION AND ELIMINATION OF ^{232}Th. Kendysh, I. N. Translated from pp 22-9 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The distribution and elimination of thorium was studied in rats after different methods of administration. A solution of thorium nitrate was administered perorally and intraperitoneally in doses of 100 mg/kg and intratracheally in doses of 10 mg/kg. The thorium content of the tissues and organs was determined chemically. Soluble thorium was poorly resorbed from the gastrointestinal tract and it persisted for a long time in the lungs and abdominal cavity when intratracheally and intraperitoneally administered. The build-up level of thorium in the investigated organs depended on the method of administration: the maximum build-up was observed after intratracheal administration; a smaller build-up was observed after intraperitoneal administration, and the minimum build-up, after peroral administration. Depending on the method of administration the kinetics of the thorium content of the organs differed. On peroral and intraperitoneal administration the thorium content of the organs (except the lungs) on the 360th day was higher than it was in the first few days following the administration, whereas on intratracheal administration it was significantly lower. The prolonged retention of thorium in the lungs on intratracheal administration in this case warrants the assumption that the lungs are the critical organ. The elimination of thorium occurred chiefly in feces and to a smaller degree in urine, in amounts that depended on the pathway of administration. The bulk of the elimination occurred within the first ten days. (M.M.B.)

22154 (AEC-tr–6944, pp 35-43) DISTRIBUTION OF ^{233}Pa IN THE ORGANISM OF THE RAT. Zalikin, G. A. Translated from pp 30-6 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

New findings are presented on the distribution of ^{233}Pa in the organs of rats following administration of 0.5 ml of a citric acid solution (2 μCi per ml) into caudal vein, trachea, or stomach. Activity was measured with an end-window counter. After intravenous and intratracheal administration most of the isotope was deposited in the skeleton (40%) where it remained firmly bound. As much as 30% of the introduced activity was found in the blood during the 30 min period following administration, 16% during the first 6 hr and 5% during the first 24 hr. Absorption from lung tissues was slow and absorption from the gastrointestinal tract was insignificant. (M.M.B.)

22155 (AEC-tr–6944, pp 44-53) EFFECT OF PATHWAY OF ADMINISTRATION ON THE BEHAVIOR OF COLLOIDAL GOLD (^{198}Au) IN THE ORGANISM OF WHITE RATS. Kalistratova, V. S.; Moskalev, Yu. I.; Serebryakov, N. G. Translated from pp 36-44 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effect of the pathway of administration on the absorption, distribution, and elimination of colloidal gold was studied. Rats were given 30 μCi of a solution of colloidal ^{198}Au (particle size 75 tmk [sic], content of isotope gold carrier 1 mg/ml, aqueous medium, pH 7.3). Activity was measured with respect to γ-radiation by means of an end-window counter and a "B" type instrument. The major accumulation was in the organs of the reticuloendothelial system, especially in the liver, spleen, and lymphatic nodes. The periods of maximum build-up of the isotope depend on the pathway of its administration. Colloidal gold is poorly absorbed from the site of administration, particularly when administered per os (0.6 to 1.0%), into the lungs (12.4%), subcutaneously (18.1%), and intraperitoneally (23.9%). The greatest amount of ^{198}Au is eliminated when it enters the organism per os (99.4% within four days); when it enters the organism via other pathways, the eliminated amount of the isotope is low (from 0.8% for subcutaneous administration to 2.7% for intratracheal). (M.M.B.)

22156 (AEC-tr–6944, pp 54-60) DISTRIBUTION AND BUILD-UP KINETICS OF ^{131}I IN THE THYROID GLAND ON CHRONIC PENETRATION INTO THE ORGANISM. Mukhamedov, T. Translated from pp 45-50 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1968.

An investigation was made of the effect of noise on the distribution, build-up, and elimination of ^{131}I by dogs. Daily subcutaneous injections of the isotopes (4 to 5 μCi/kg) were given to ten dogs for eight months. Five of the dogs were also exposed to daily three hr intervals of noise (100 to 105 db). The buildup of ^{131}I was determined with the aid of a gamma-pickup daily for two weeks and then weekly. The build-up was of a multistage nature (increase in build-up in the thyroid gland followed by the onset of an equilibrium state and ultimately by decrease in the build-up). Noise as an unfavorable factor contributed to greater build-up of ^{131}I in the thyroid gland and prolonged the duration of the equilibrium state. The distribution of ^{131}I in most of the organs and tissues of the experimental animals of both groups was nearly the same. In the presence of noise comparatively higher build-up levels were recorded for the thyroid gland, gall bladder, kidneys, lungs, and brain. In the dogs exposed to both ^{131}I and noise the amount of the isotope eliminated in urine is smaller during each stage than in dogs exposed to the action of ^{131}I alone. (M.M.B.)

22157 (AEC-tr-6944, pp 61-6) BUILD-UP DYNAMICS OF CHRONICALLY ADMINISTERED ^{144}Ce IN THE ORGANISM OF ANIMALS. Grigoryan, Kh. V. Translated from pp 50-5 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Tentative findings are presented on the patterns of build-up and distribution of ^{144}Ce when chronically administered per os (8×10^{-7} Ci) and when applied in a single dose (5×10^{-6} Ci) to the skin integuments of rats. Some of the latter animals were irradiated with uv (60 μR min/cm^2) 36 hr prior to the application of ^{144}Ce to their skin. The femoral bone, liver, kidneys, muscle tissue, brain and testes were collected for radiometric analysis. Following calcining the samples were placed on aluminum targets and their activity was measured with the aid of an MST-17-end-window counter and a B-2 instrument. Cerium-144 is resorbed from the gastrointestinal tract and via the skin in amounts of not more than 0.1 to 0.15% of the applied dose. When administered perorally or applied to the skin, most of the absorbed ^{144}Ce deposits in the skeleton. As the time of chronic administration of the isotope is prolonged, the percentage of the isotope depositing in the skeleton increases and the percentage depositing in the liver and other organs decreases. In the presence of ultraviolet radiation the resorption of ^{144}Ce via the skin is enhanced. (M.M.B.)

22158 (AEC-tr-6944, pp 67-77) POOLING OF ^{90}Sr IN THE BONY TISSUE. Zapol'skaya, N. A.; Borisova, V. V.; Fedorova, A. V.; Shamov, V. P. Translated from pp 55-63 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The dynamics of the build-up and elimination of ^{90}Sr from bony tissue when applied in single doses and chronically were investigated. The experiments were carried out on rats under conditions of chronic and single peroral administration of ^{90}Sr in a concentration of 8×10^{-2} μCi per animal. One hundred rats divided into three groups were kept under observation. Group 1 received daily doses of ^{90}Sr for one year, group 2 received daily doses for 100 days, after which the rate of elimination of this isotope was observed, and group 3 received a single dose each. Three days prior to their slaughter the animals were placed in metabolic cages and their urine and feces were separately collected each day. Radiometric analysis was based on femoral bones of the animals, which were calcined in a muffle furnace at 600°C. The calcined samples were let stand for 15 days until the onset of an equilibrium between ^{90}Sr and ^{90}Y, after which the sample activity was measured with the aid of a BFL counter and a B-2 instrument that was calibrated with respect to a ^{90}Sr + ^{90}Y solution whose activity had been measured by means of a 4π-counter correct to 5 percent. The concentration of ^{90}Sr in the animals in group 1 continually increased without reaching an equilibrium state. The concentration toward the end of the year was $225.3 \times 15.2 \times 10^{-2}$ μCi per skeleton. The ^{90}Sr content of the bony tissue 24 hr following the administration of the single dose was 24% of the dose administered. On subsequent days the activity sharply diminished and after two months was 74% below the initial level. Subsequently, however, the rate of elimination of this isotope from the bony tissue markedly slowed down; after three months there remained $(4.2 \pm 0.4) \times 10^{-2}$ μCi, and after five months, $(3.8 \pm 0.4) \times 10^{-2}$ μCi. After the administration of a single dose the activity content of the diurnal excretions dropped by a factor of nearly 10 during the following month, after the chronic administration of the isotope it dropped by a factor of only 2.5 over a corresponding period. A two-system model was evaluated for analysis of the data. (M.M.B.)

22159 (AEC-tr-6944, pp 78-81) CONTENT OF STABLE STRONTIUM IN HUMAN BONY TISSUE AND DIET. Dibobes, I. K.; Skryabin, A. M.; Lebedev, V. M.; Panteleev, L. I. Translated from pp 63-5 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The results of further investigation of the content of stable Sr in the human bony tissue and diet are presented. Bone samples from persons of various age (beginning with intrauterine fetuses and the newborn and ending with persons 80 yr old) were analyzed. Entire-skeleton analysis was carried out in the case of intrauterine fetuses, cadavers of the stillborn and of children up to one yr old, while in all the other cases only costal bones were analyzed. Altogether 115 samples were analyzed, of which 10 were from 5 to 8 month old intrauterine fetuses; 20, from newborn infants; 20 from children up to 5 yr old; 20 from children 6 to 7 yr old; and 45 from persons older than 18. In addition, 35 samples of the total daily diet of adult urban and rural inhabitants were analyzed. The content of stable Sr and Ca was determined in the ash of the samples. The lowest concentrations of Sr were in the intrauterine fetuses and newborn, 0.20 ± 0.03 and 0.24 ± 0.03 mg/g of Ca respectively. With increasing age there occurs an absolute and relative increase in the Sr present in the skeleton per g of Ca. After 20 yr the concentration of Sr stabilized and remained constant until death. During this period there was an average of 0.45 ± 0.05 mg of Sr per g of Ca. The increase of strontium content of the skeleton doesn't proceed uniformly with age. The rate is high during the first three yr but is followed by a decrease until about the seventh yr after which it again increases until the 20th yr. The ^{90}Sr content of the integral daily diet of adult humans varies within the limits of from 0.9 to 4.5 mg. The mean daily intake of stable strontium in food was 1.6 ± 0.12 mg. The ratio of strontium to calcium is 2 : 3. These findings may be used to derive the coefficients of discrimination of strontium with respect to calcium in the link food-bony tissue. The discrimination coefficient for the link food-bony tissue of adult human is 0.2, while in the link mother's food-bony tissue of newborn infant it amounts to 0.1. It is also possible to estimate at 0.5 the placental discrimination of ^{90}Sr with respect to calcium during the transport of these elements from the mother's blood to the bones of the fetus. The build-up multiplicity factor of stable strontium is 280. The derived numerical values of the discrimination coefficient and of the build-up multiplicity factor are in good agreement with most of the literature data. (M.M.B.)

22160 (AEC-tr-6944, pp 82-90) BUILD-UP KINETICS AND ELIMINATION RATE OF CHRONICALLY ADMINISTERED ^{90}Sr IN DOGS. Burykina, L. N. Translated from pp 66-72 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Thirty-two experimental dogs were given daily (except on days off) doses of the chloride salt of ^{90}Sr (2×10^{-1} to 2×10^{-4} μCi/kg) in an equilibrium with ^{90}Y for 3-3.5 yr. The experimental animals, which at the outset of the experiment were 1.5 to 5 yr old, were divided into four groups in accordance with the doses of isotope administered. To clarify the effect of age on the levels of ^{90}Sr build-up in the dog, an additional ten dogs (two groups of three dogs each 1.5-2 yr old and 10-12 yr old and one group of puppies four months old) were utilized in a separate experiment performed in collaboration with E. I. Yartsev. The build-up rate of ^{90}Sr decreased with increasing time of its chronic administration to the dog. The time dependence of the ^{90}Sr build-up rate in the dog skeleton is satisfactorily described by the power function. Radiometric and autoradiographic studies established a nonuniform distribution of ^{90}Sr both in individual bones of the skeleton and in various parts of the same bone. As the time of chronic administration of ^{90}Sr increased (from one month to one-and-one-half yr) the degree of nonuniformity of its content in the skeleton decreased by a factor of more than 3. The patterns of placental transfer of ^{90}Sr from the mother to the offspring following cessation of administration of ^{90}Sr to the mother's organism were established. The levels of the placental transfer of ^{90}Sr decreased by a factor of 15 times after 2.5 yr from the date of cessation of the chronic administration of this isotope and 50 times after 4 to 5 yr. The effective half-life of ^{90}Sr in the skeleton following the cessation of chronic administration proved to be highly similar (1750 and 1945 days) for both groups of experimental animals (daily administered doses 2×10^{-1} and 2×10^{-2} μCi/kg for 3 to 3.5 yr). The power function satisfactorily described the elimination of ^{90}Sr from the dog skeleton following the cessation of chronic poisoning. (auth)

22161 (AEC-tr-6944, pp 91-8) RADIOMETRIC STUDIES OF THE LUNGS IN THE PROCESS OF THE DEVELOPMENT OF CANCER INDUCED BY INTRATRACHEAL ADMINISTRATION OF ^{144}Ce FLUORIDE. Ivanov, A. E.; Gorel'chik, K. I. Translated from pp 72-8 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

An investigation was carried out on the patterns of distribution and elimination of the emitter in the course of carcinogenesis. Lung cancer was induced in rabbits by means of intratracheal administration of a colloidal solution of cerium fluoride (^{144}CeF$_3$). The radioactive substance was transcutaneously injected with a syringe into the tracheal lumen without employing narcosis or lacerating the skin. Each rabbit was injected with 0.5 ml of a solution of ^{144}Ce fluoride having the activity of 25 μCi. The mean diameter of the colloidal particles was 25 mμ, and they had a charge of 2.4×10^{-2} μV and a pH value of 6.0 to 6.5. Following the injection of ^{144}Ce the thoracic cages of the rabbits were systematically scanned, thus making it possible to trace the dynamics of the distribution of this isotope in the lungs of each animal throughout the experiment. It was found that ^{144}C was nonuniformly distributed. By virtue of the physiological features of the lungs, it gradually concentrated near the radix pulmonis and produced a blastomogenic effect. The decrease in the activity of ^{144}Ce in the lungs occurred in two stages. The first stage was short and dominated by biological mechanisms of lung purification, while the second developed slowly and showed a definite equilibrium between the elimination of ^{144}Ce from the lungs and its radioactive decay. Calculations of absorbed energy in the case of inhalational or intratracheal entry of radioactive substance must take into account the pattern of distribution of that substance in the lungs. This is important to keep in mind in an analysis of the blastomogenic effect of radioactive substances in the larger animals as well as in theoretical calculations with respect to humans. (tr-auth)

22162 (AEC-tr-6944, pp 99-105) ABSORPTION OF ^{239}Pu THROUGH THE SKIN OF ANIMALS AND ITS DISTRIBUTION IN THE ORGANISM. Khodyreva, M. A. Translated from pp 78-83 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The absorption of ^{239}Pu through the intact skin of animals and its attendant distribution in the organism was investigated. A solution of a nitrate salt of plutonium (pH = 5) was applied to a shorn patch of the skin of 15 adult rabbits. The activity in the blood was determined by counting the tracks of α-particles of ^{239}Pu on A-2-50 type thick-film plates. On the 14th day the animals were killed, weighed suspensions of the organs were collected and calcined in a mixture of nitric acid and hydrogen peroxide. Part of the solution was applied to a target and analyzed with the aid of a D-type counter. On the 14th day following the application of a solution of nitrate salt of ^{239}Pu to the skin in amounts of 0.4 and 4 μCi/cm^2 the organism of the animals contained 0.15% of the dose applied. The bulk was detected in the skeleton, liver, and muscles. (tr-auth)

22163 (AEC-tr-6944, pp 106-12) PENETRATION OF ^{210}Po THROUGH WOUNDS INTO THE ORGANISM. Zotova, M. G. Translated from pp 83-8 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

A comparative investigation was made in 200 rats of the rates of absorption of Po from skin wounds and skin-and-muscle wounds contaminated with ^{210}Po. Skin wounds (sectioning of the skin down to the fascia) were produced on the well-shorn skin of the back in the lumbosacral region to the left of the vertebra in one group of rats, while linear (3 mm long) skin-and-muscle wounds (5 mm deep) were produced in the other group. A solution of ^{210}Po (0.05 ml) in bismuth was applied to the wound surface with the aid of a micropipette (0.0025 μCi per rat). The dynamics of blood activity was investigated by the autoradiographic method and the radioactivity of the carcasses and excised sections of wounds, by the method of incomplete acid hydrolysis. The process of the absorption of ^{210}Po from the wound into the organism was rapid. Absorption of polonium from skin wounds was faster than from skin-and-muscle wounds. Excision of wounds was effective in the early stages. Elimination of the contaminated sections of skin wounds was effective not later than within the first three hr following injury, and of skin-and-muscle wounds, not later than within the first two days. Treatment with unithiol must be preceded by excision of the wound. Excision of wounds is an essential first-aid measure in cases of contamination with a radioactive substance. (tr-auth)

22164 (AEC-tr-6944, pp 113-21) DISTRIBUTION OF ^{131}I IN RENAL TISSUE AND ITS EFFECT ON THE MORPHOLOGICAL STRUCTURE OF THE RAT KIDNEY. Baikova, V. S. Translated from pp 88-95 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The dynamics of structural changes in renal tissue was traced following the administration to animals of ^{131}I in doses corresponding to therapeutic doses in the clinic. Further, the pattern of distribution of ^{131}I in renal tissue (in the organ which is the chief pathway of elimination of this isotope by the organism) was investigated. Thirty-one rats received a single subcutaneous dose of ^{131}I in the amount of 1 μCi per gram of body weight. After 1, 3, 7, 15, 22, 30, and 45 days the kidneys were removed. The material obtained after the 1st, 3rd, and 7th days of experiment was histoautoradiographically examined and at every stage the structure of the renal tissue was histologically investigated. The highest content of ^{131}I was observed in the epithelium of the convoluted tubules 24 hours following the administration of the isotope. The least content of ^{131}I was found in the epithelium of the collecting tubules. During the early stages (1st to 3rd days) the predominant manifestations were hemodynamic disorders and albuminous degeneration, which became more marked on the 7th day. Subsequently, both types of manifestations decreased in virulence. The inflammatory infiltration, which reached its peak on the 8th to 15th day, tended to culminate in scarring toward the end of the experiment. At every stage lymphocytes and histiocytes were found in renal stroma and similarly perivascular edema was observed throughout the period of experiment. Subsequently (after one and one-and-one-half months) hyalin cylinders were detected in the lumen of the collecting tubules. At every stage of investigation, turgor of the epithelium of the Shumlyanskiĭ-Bowman capsule was observed. (tr-auth)

22165 (AEC-tr-6944, pp 122-30) CONTENT AND MICRODISTRIBUTION OF ^{239}Pu AND MORPHOLOGICAL CHANGES IN THE LUNGS OF RATS INTRATRACHEALLY ADMINISTERED THIS ISOTOPE. Erokhin, R. A.; Koshurnikova, N. A.; Lemberg, V. K.; Lyubchanskii, E. R.; Reshetov, G. N. Translated from pp 96-103 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The behavior and microdistribution of plutonium nitrate and sodium plutonyltriacetate in the lungs of rats, and the morphological changes, at various periods following the intratracheal administration of ^{239}Pu in a dose of 7 μCi/kg was investigated. The ^{239}Pu content of the lungs following the administration of the nitrate salt of plutonium is 5 to 10 times as high as following the administration of sodium plutonyltriacetate. The elimination of ^{239}Pu following its administration in the form of the salts named above obeys the exponential law, except that on administration of sodium plutonyltriacetate the elimination occurs at a much more rapid rate. The microdistribution of ^{239}Pu in the lungs of rats in the early stages beginning with the 3rd to 4th day is relatively uniform but subsequently it becomes focal, around vessels and bronchi. A large amount of ^{239}Pu is transported from the lungs by the macrophages to the regional lymphatic nodes. Histological changes in the lungs depend on the pattern of microdistribution of ^{239}Pu and arise chiefly in the foci of build-up of this radioactive isotope. The distinctness and timing of the pathological changes depend on the built-up ionization dose. The earliest changes are dystrophy and desquamation of the bronchial and alveolar epithelium as well as perivascular edema. This is followed by chronic inflammation of a chiefly productive nature. The pathological process results in the onset of pneumosclerosis and occasionally lung cancer. The sclerotic process at first develops in the customary indirect manner on the basis of proliferation of connective-tissue cellular elements with formation of fibrous structures. At a later stage this is also accompanied by direct acellular sclerosis against a background of lympho- and hemodynamic disorders and hypoxia. (tr-auth)

22166 (AEC-tr-6944, pp 131-7) EXPERIMENTAL VERIFICATION OF VARIOUS MODELS BASED ON THE METABOLISM OF ^{90}Sr AND ^{137}Cs IN THE BONY TISSUE. Borisova, V. V.; Zapol'skaya, N. A.; Pavlitskaya, E. D. Translated from pp 103-8 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The question of the applicability of a mathematical function to the description of experimental findings on the metabolism of osteotropic isotopes, the pattern of distribution and elimination of ^{90}Sr from individual bones of the skeleton, and certain methodological aspects of the calculation of total activity of the skeleton were investigated. The rates of elimination of ^{90}Sr from various bones of the skeleton were studied following the peroral administration of a single dose of 8×10^{-2} μCi of ^{90}Sr to young rats having an original weight of 120 ± 10 g each. At various periods afterward, some of the animals were killed and the total weight of the skeleton as well as of individual bones of the skeleton was determined, the ^{90}Sr content per g of individual bones was analyzed and the mean activity per g of entire bony tissue was established. The rate of elimination of ^{137}Cs from bony tissue was determined both after single-dose and after chronic administration. In the single-dose experiment the isotope was given per os in the amount of 3×10^{-6} Ci. In the chronic administration experiment, white rats received 4×10^{-8} Ci of ^{137}Cs daily for 200 days per animal. It was found that ^{137}Cs metabolism in bony tissue was faster than ^{90}Sr metabolism. The rate of elimination of both ^{90}Sr and ^{137}Cs from the bony tissue was not a constant and hence the metabolism of these isotopes could not be described by the simple exponential model. The final selection of a mathematical model for describing ^{90}Sr metabolism requires further investigation. (tr-auth)

22167 (AEC-tr-6944, pp 138-42) MATHEMATICAL MODELS DESCRIBING THE KINETICS OF THE BUILD-UP AND ELIMINATION OF ^{90}Sr IN DOGS AND SHEEP. Sarapul'tsev, I. A.; Shamov, V. P.; Panchenko, I. Ya. Translated from pp 108-12 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The kinetics of the build-up and elimination of ^{90}Sr from dogs given single peroral doses was described by both exponential and power models. The build-up of ^{90}Sr when chronically administered to dogs and sheep was calculated from the power model using the constants derived from the single-dose administration of the isotope. These calculations may also be applied to the build-up of ^{90}Sr in man. (M.M.B.)

22168 (AEC-tr-6944, pp 143-56) PHYSICOMATHEMATICAL ASPECTS OF THE METABOLISM AND STANDARD LEVELS OF

RADIOACTIVE ISOTOPES IN THE GROUP OF ALKALI-EARTH ELEMENTS. Shamov, V. P. Translated from pp 112-22 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

An analysis of the dynamics of the metabolism and tissue doses for osteotropic isotopes in the alkali-earth elements makes it possible to numerically relate the activity of daily intake Q_0 to both the dose power W(t) and the absorbed dose D(t). When establishing the permissible norms for single-dose administration of osteotropic isotopes it is most expedient to employ the monocellular and two-system variants of the exponential model. When establishing the permissible norms for chronic administration of osteotropic isotopes it is most expedient to employ the power model or the two-power model. Using the monocellular variant of the exponential model to establish the permissible norms for chronically received osteotropic isotopes (particularly for isotopes with a long effective half-life) is not a justified procedure. (tr-auth)

22169 (AEC-tr-6944, pp 157-64) BUILD-UP AND ELIMINATION OF ^{32}P BY PROTOCOCCAL ALGAE SCENEDESMUS QUADRICAUDA. Malashina, S. G. Translated from pp 122-8 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The metabolism of ^{32}P by Scenedesmus quadricauda was investigated as a function of temperature, cell concentration, illumination, and death. Tap water was used with 1×10^{-7} Ci/liter of $Na_2\,^{32}PO_4$. The algae were added to the solution for one hour after which they were removed by centrifugation and the content of ^{32}P was measured. The elimination rate of ^{32}P was measured after resuspension of algae in pure water. Cells which had died naturally and cells which were heat killed (60°C) were also tested. The higher the water temperature of those temperatures tested (22, 16, and 3°C) the more ^{32}P was absorbed by the algae. More absorption occurred in the light than in the dark and more per cell at lower cell concentrations. Living and heat killed algae eliminated ^{32}P at a faster rate than algae which had died naturally. (M.M.B.)

22170 (AEC-tr-6944, pp 165-77) FEATURES OF THE BEHAVIOR OF CERTAIN RADIOACTIVE ISOTOPES IN THE ORGANISM OF ANIMALS DEPENDING ON PHYSICOCHEMICAL PROPERTIES OF COMPOUNDS. Sedov, V. V.; Koval'chuk, N. D. Translated from pp 129-38 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

An investigation was made of the effect of the properties of different compounds labeled with radioisotopes on the metabolism of the isotope by dogs, rabbits, mice, and rats. A marked variability in the build-up of ^{131}I in the thyroid gland was observed, both in the periods and concentration of this isotope. Features of the behavior of certain ^{131}I-tagged organic compounds in the organism of animals were established. Rose bengale chiefly concentrated in the liver; cardiotrast, in the kidneys and, to a smaller extent, liver; iodohippurane, in the kidneys; iodognost, in the gall bladder and liver. Albumin circulated in the blood for a long time. Marked differences were observed in the distribution of tri- and hexavalent chromium: trivalent chromium combined with plasma albumins, whereas hexavalent chromium penetrated through the membrane of the erythrocytes and tagged the erythrocyte. The build-up of intramuscularly injected ^{198}Au in the regional lymphatic nodes varied depending on the medium and on the dilution of the radioactive colloidal gold with saline or procaine solution. The significance of the experimental findings on the biological effect of radioactive isotopes was pointed out with respect to substantiating the possibility of the medical-diagnostic utilization of these isotopes in clinical practice. (M.M.B.)

22171 (AEC-tr-6944, pp 178-82) DISTRIBUTION OF ^{137}Cs IN THE ORGANISM OF RABBITS FOLLOWING REMOVAL OF THE UPPER CERVICAL SYMPATHETIC NODE. Galibin, G. P. Translated from pp 139-42 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Experiments to clarify whether ^{137}Cs penetrates into the brain and to what extent the removal of the sympathetic node influences the distribution of this isotope in the brain and other organs and tissues were performed on 18 male rabbits weighing 2300–2400 g each. The upper cervical sympathetic node on the left side was excised under local anesthesia with 2% solution of novocain. There were no postoperative complications. Twenty-four hours following the operation a solution of cesium chloride, pH ~3.0, with specific activity of 70 μCi/cc was subcutaneously injected in the amount of 30 μCi per kg body weight; at the same time, the same dose of ^{137}Cs was injected into intact animals. After 1, 4, and 16 days from the date of injection of the isotopes the rabbits were killed and the activity content of various organs and tissues of the animal, including the brain, was analyzed. Samples of organs, 400 mg each, were first dried at 70–80°C; the dried suspensions were compressed into uniform tablets and the activity was determined with the aid of a B-type instrument. In each case a correction for natural absorption was introduced. Samples of brain were taken separately from the right and left halves. Cesium-137 was detected in various divisions of the nervous system. Its maximum concentrations in the brain following subcutaneous injection was found after four days (0.06% of the injected dose). The highest concentration of ^{137}Cs was found in the pituitary, where it was two to four times as high as in the brain. Excision of the upper cervical sympathetic node did not influence the ^{137}Cs distribution in the brain and other organs. (tr-auth)

22172 (AEC-tr-6944, pp 183-7) EFFECT OF ULTRAVIOLET RADIATION AND VITAMIN D_2 ON CERTAIN ASPECTS OF ^{90}Sr METABOLISM IN RATS. Mirzoyan, A. A. Translated from pp 142-6 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The kinetics of the build-up in and elimination of ^{90}Sr from bony tissue and the effect of ultraviolet radiation and vitamin D on these processes were investigated. Five hundred rats were divided into three groups: one received daily ^{90}Sr in the concentration of 9×10^{-2} μCi per rat, another was additionally exposed to ultraviolet radiation in the dose of 420 μR-min/cm^2, and a third received daily doses of ^{90}Sr amounting to 9×10^{-2} plus daily doses of 200 units of vitamin D_2. Ultraviolet irradiation of animals and administration of vitamin D_2 markedly enhanced ^{90}Sr build-up in the skeleton. The build-up coefficients after 90 days averaged 16 for animals subjected to the combined effect compared with 10 for animals which received only ^{90}Sr. During the first month the ^{90}Sr elimination rate was faster in animals which previously received vitamin D_2 and were irradiated with ultraviolet light. These special features of ^{90}Sr metabolism apparently are associated with the intensification of the mineral metabolism of bony tissue by ultraviolet irradiation and vitamin D_2. (tr-auth)

22173 (AEC-tr-6944, pp 188-93) EFFECT OF CERTAIN FACTORS ON THE BEHAVIOR OF ^{111}Ag IN THE ORGANISM OF ANIMALS. Kalistratova, V. S.; Kogan, A. G.; Kozlova, M. D. Translated from pp 146-51 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effects of method of administration and isotope carrier on the metabolism of ^{111}Ag were studied. Ninety rats were divided into groups. The isotope was administered as the chloride in a dose of 1 μCi per rat (200–250 g) and isotope carrier in a dose of 0.00001 μg per rat to one group and 0.01 μg to another. Different groups of rats received intravenous, subcutaneous, peroral, or intratracheal administration. Silver-111 was widely distributed in the organs and tissues, but chiefly accumulated in the reticuloendothelial system. Most of ^{111}Ag was eliminated within 4 to 5 days, and 91.3% of this was eliminated in the feces. The pathway of administration affected the absorption of ^{111}Ag. The use of isotope carrier (0.01 μg per rat) resulted in longer retention by the reticuloendothelial system. (M.M.B.)

22174 (AEC-tr-6944, pp 194-204) ROLE OF ISOTOPE AND NON-ISOTOPE CARRIERS IN ^{90}Sr METABOLISM IN ANIMALS. Annenkov, B. N. Translated from pp 151-9 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The metabolism of radioactive strontium is largely determined by the intake of an isotope or non-isotope carrier by the organism. Given an insufficient or low penetration of divalent cations and radioactive strontium into the digestive tract, the build-up of radioactive isotope in the skeleton is greater than in the presence of a high or excessive intake of the carriers. The retarding effect of divalent cations on the deposition of radioactive strontium in the organism was established in experiments with certain species of laboratory and agricultural animals. Attempts to reduce the build-up of radioactive strontium in the human organism by prescribing a diet containing a high concentration of stable isotopes of calcium or strontium have not been crowned with success, however. The reduction in the deposition of radioactive strontium in the organism is associated with the effect of carriers on the metabolism of radioactive isotopes in the metabolic-chain links: digestive tract ⇌ blood, blood ⇌ skeleton and blood ⇌ kidneys. On peroral administration of radioactive strontium the effect of cations on the absorption of the radioisotope is of major significance, while their effect on the other links of the chain of metabolism of radioactive strontium is smaller and less conclusive. In cases of parenteral administration of radioactive strontium the protective effect of the carriers with respect to the build-up of the radioactive isotope is chiefly conditioned by the effect of cations on the renal excretory function. The effectiveness of the carriers in reducing the deposition of radioactive strontium depends on the age of the animal and the dose and period of administration of divalent cations following the penetration of radioactive isotope into the organism. Prolonged intake of calcium, strontium or magnesium via the digestive tract during the period following the incorporation of radioactive strontium does not appreciably affect the elimination of this radioactive isotope. (tr-auth)

22175 (AEC-tr–6944, pp 205-14) ^{90}Sr METABOLISM IN THE ORGANISM OF RATS KEPT ON EXCESS CALCIUM DIET WITH CHRONIC INTRAGASTRIC ADMINISTRATION OF ^{90}Sr. Buldakov, L. A.; Erokhin, R. A. Translated from pp 159-67 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effect of the content of calcium in the diet on the metabolism of strontium by rats was investigated. Strontium-90 in a chloride solution (pH 3) was introduced in a single dose into the stomach. The resulting ^{90}Sr elimination doses from the skeleton amounted to 0.015, 0.1, 0.5, 1.0, 2 and 74 μCi per rat. During chronic experiments the strontium dose was 0.015 μCi daily, over a period of from 50 to 200 days; the observation of the ^{90}Sr content of the skeleton continued for 64 to 256 days from the date of last injection. After chronic administration of strontium the content in the skeleton increased during the first 150 days and at that period amounted to 351 ± 43.2% of the daily dose for females (diet with 2.4 percent calcium) and 693 ± 71 percent of the daily dose for males (diet with 1.4% calcium). Given a high-calcium diet (2.4%), strontium build-up in the skeleton of males on the 200th day was higher (838 ± 169% of the daily dose) than in females. The buildup of chronically administered strontium in the skeleton of periodically pregant and lactating females was on the 200th day 30% higher than in the non-parturient rats. The ^{90}Sr content in the muscles of parturient and non-parturient females did not exceed 5.23 to 7.40% of the daily dose and was 20 to 60 times lower than in the skeleton. Following single-dose administration of strontium (0.015 to 74 μCi) and given a mean deposition of 5.45 ± 0.12%, 71.5% of the isotope in the skeleton was eliminated at a constant rate of $\lambda = 0.229$ per day, and the remaining 28.5 percent at a constant rate of 0.00129 per day. Following chronic administration the proportion of the rapidly metabolized strontium decreased while the proportion of the slowly metabolized strontium increased. In rats receiving ^{90}Sr for 100 days the decrease in content occurred with a single constant of 0.00045 per day and after 200 days of administration no decrease in activity in the skeleton occurred for 64 days. The offspring received an increasing amount of strontium with each successive period of intrauterine growth, pregnancy and lactation. Thus, while during the first pregnancy the ratling received 1.48 ± 0.07% of the daily dose via the placenta and 5.77% with milk, during the fourth pregnancy it received 2.82 ± 0.10% via the placenta and 41% with milk. (M.M.B.)

22176 (AEC-tr–6944, pp 222-6) BEHAVIOR OF ^{45}Ca AND ^{90}Sr AND THEIR INTERACTION DURING DIFFUSION ACROSS A RIGID MEMBRANE AND IN PROCESSES OF ABSORPTION AND BUILD-UP IN THE RAT ORGANISM. Malkina, R. M.; Puchkova, S. M.; Panteleeva, A. P. Translated from pp 172-6 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The behavior of calcium-45 and of strontium-90 were compared during absorption and accumulation by rats. The diffusion of calcium and of strontium from solutions of their chlorides (0.01 to 0.25 M) across the wall of a bull's bladder was observed. No differences were found between metabolism of calcium and strontium in rats (normal, prednisolone-treated, and rachitic) or in their diffusion across a membrane. (M.M.B.)

22177 (AEC-tr–6944, pp 251-7) STATE OF IMMUNOLOGICAL REACTIVITY IN RATS POISONED WITH TRITIUM OXIDE AND IN THEIR OFFSPRING. Shal'nova, G. A.; Kuz'mina, T. D. Translated from pp 196-202 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Studies were made of the effects of tritium poisoning on the microflora of rats. Skin in the caudal region and mucous membrane in the mouth were cultured for Escherichia coli (Endo agar) and skin for mannitol-decomposing cocci (mannitol-bromthymol-blue agar) over a period of 12 months. Controls, tritium oxide inoculated (0.01 to 0.3 μCi/g intraperitoneally), and their offspring were tested periodically. The mouths of tritium treated rats contained much larger numbers of E. coli than the control rats. The skin of both tritium rats and their offspring also bore larger numbers of E. coli and mannitol-decomposing cocci than on control rats. In all cases the increased microflora was proportional to dose and correlated with the clinical course of poisoning. (M.M.B.)

22178 (AEC-tr–6944, pp 340–4) CERTAIN ASPECTS OF THE BIOLOGICAL EFFECT OF ^{45}Ca. Ternov, V. I. Translated from pp 266-70 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effect of chronic administration of moderate doses of ^{45}Ca on animals was studied. The isotope was given daily (in their drinking water) to three groups of rats in doses of 0.0009, 0.009, and 0.09 μCi/kg. A fourth group was given $CaCl_2$ in amounts equivalent to the highest dose of radioactive calcium. None of the animals had visible signs of illness. Animals receiving the highest dose (absorbed dose over nine months totalled 201.5 rad) showed distinct signs of chronic radiation injury to the blood-forming system and to individual immunity factors as early as the third month of chronic administration. Animals receiving the intermediate dose (total absorbed dose was 23.8 rad) also showed injury to blood formation and immunity, but no changes were observed in rats receiving the lowest dose. It was concluded that 3×10^{-9} Ci/l of ^{45}Ca is a satisfactory maximum permissible concentration for human water supplies. (M.M.B.)

22179 (AEC-tr–6944, pp 426-33) CHANGES OCCURRING IN CERTAIN BIOCHEMICAL AND IMMUNOLOGICAL INDICATORS IN MICE CHRONICALLY POISONED WITH ^{90}Sr. Goloshchapov, P. V.; Nikiforova, V. A. Translated from pp 334-40 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effects of internal ^{90}Sr on immunity and serum proteins were studied in mice. After the administration of small amounts of ^{90}Sr the general albumin content of the blood serum of the animals varied to an insignificant extent; the amount of alpha-globulins increased slightly while the content of gamma-globulins decreased slightly. Chronic poisoning of mice and their offspring with ^{90}Sr in amounts of 3.5×10^{-4}, 3.5×10^{-3}, 3.5×10^{-2}, and 3.5×10^{-1} μCi depressed somewhat the defense-adaptation functions of the mice, as manifested in the depression of the bactericidal function of the skin, the increase and qualitative change of the microflora of the skin integuments and oral cavity, and decrease in antibacterial immunity. (M.M.B.)

22180 (AEC-tr–6944, pp 641-50) PENETRATION OF ^{90}Sr FROM VARIOUS FOODSTUFFS AND THE EFFECT OF COMPOSITION OF THE DIET ON ITS ASSIMILATION. Dubrovina, Z. V.; Dobryakova, G. V.; Malkin, P. M.; Nesterenko, V. P.; Fadeev, A. P.; Tabarchuk, A. D. Translated from pp 509-16 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Strontium-90 in foodstuffs is associated with various component parts; thus, while in meat the bulk (more than one half) of the radioactive isotope is bound in the water-soluble fraction, in vegetable products (grain, potatoes, peas) the greater part of the strontium is associated with the hydrolyzing fractions, apparently of the phytin and pectin types. Hence, it might be expected that the assimilability of radioactive strontium differs depending on the foodstuff intaken. However, our repeated chronic experiments on rats, both adults and the young, showed that, given a normal composition of the diet, the assimilation of ^{90}Sr from meat, milk, grain, potatoes and peas was identical and did not differ from its assimilation from a solution of nitrate salt. Experiments were carried out on animals fed with the same diet but with different chemical compounds of strontium that can exist in foodstuffs (chloride, acetate, citrate, sulfate, phosphate, carbonate, oxalate and phytate of strontium); the concentration of the added stable strontium exceeded the normal daily intake by not more than 2 to 4 times. These experiments showed that under such conditions the absorption of radioactive strontium from the gastrointestinal tract and its retention in the skeleton were more or less identical in all the groups, i.e., that the assimilation of radioactive strontium was independent of the chemical form in which it was present in the diet. However, it was found that the assimilation of strontium-90 was somewhat influenced by the composition of the integral diet. The experiments confirmed the importance of normal calcium nutrition as a prophylactic measure against the absorption of radioactive strontium. Other ingredients in the diet also influenced the assimilation of ^{90}Sr, but their effects were ambiguous and will need further research for elucidation. (M.M.B.)

22181 (AEC-tr–6944, pp 651-6) ACCELERATING THE ELIMINATION OF CERTAIN ISOTOPES FROM THE ORGANISM WITH THE AID OF OSMOTIC DIURESIS. Zakrzhevskii, E. B.; Koval', Yu. F.; Evlanova, L. I. Translated from pp 517-20 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

An investigation was made of the efficiency of osmotic diuresis for elimination of isotopes from rabbits. Isotopes were injected in nontoxic doses (sodium iodide, 100 mg/kg; cesium chloride, 200 mg/kg; strontium chloride, 50 mg/kg; and barium chloride, 1 mg/kg) into the ear veins of rabbits placed in metabolic cages. Subsequently, the rabbits were injected with 20% glucose solution at the rate of 60 ml/kg per hour. As the diuresis increased, the concentration of the injected glucose gradually dropped to 10 to 7%. To offset the loss of electrolytes, the glucose solution was treated with sodium chloride (8 to 16 m-equiv/l), potassium chloride (3 to 6 m-equiv/l) and calcium chloride (0.5 to 1 m-equiv/l). The intravenous injection of the fluid and collection of urine were carried out for 4 to 11 hours. In some of the experiments, the production of osmotic diuresis was combined with the administration of potassium perchlorate (50 mg/kg), mercazolyl (0.25 mg/kg), sodium iodide (60 mg/kg) and ammonium thiocyanate (100 mg/kg). In other experiments osmotic diuresis occurred following the administration of 15% solution of mannite and 0.09 M solution of sodium sulfate. The elimination of radioactive and stable iodine as well as of stable strontium, cesium and barium were investigated. In the experiments with the administration of ^{131}I in the dose of 20 μCi/kg, elimination of this isotope ranged from 31 to 73% following osmotic diuresis performed for 3.5 to 8 hours, whereas in the control experiments during 24 hours this elimination ranged only from 3 to 33%. Osmotic diuresis increased the elimination of stable strontium and stable cesium. Sulfate diuresis accelerated the elimination of stable barium. These findings must be regarded as preliminary, since they were obtained for strontium, barium and cesium following the administration of ponderable amounts of these isotopes. Nevertheless, they give reason to believe that osmotic diuresis is a means of accelerating the elimination from the organism of the radioactive substances circulating in the blood. (M.M.B.)

22182 (AEC-tr-6944, pp 657-69) BEHAVIOR OF RADIOACTIVE ZINC IN THE ORGANISM AND THE ACCELERATION OF ITS ELIMINATION. Arkhangel'skaya, G. V.; Il'in, L. A.; Norets, T. A. Translated from pp 520-30 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The results of an investigation of the effect of DTPA on the distribution and elimination of ^{65}Zn, in rats is presented. A solution of ^{65}Zn in chloride form was administered intraperitoneally in a single dose of 0.1 μCi/g (specific activity of the solution = 20 μCi/ml; gravimetric content of zinc in solution = 1.4×10^{-4} g/ml). Na_3Ca-DTPA (diethylenetriaminepentacetic acid) also was injected intraperitoneally thrice within one hour prior to administration of the isotope as well as 6 and 24 hours following its administration, in doses of 100 μmoles each. The treatment with DTPA within one hour of the administration of ^{65}Zn resulted in a 10-fold decrease in ^{65}Zn content in all the organs and tissues tested. The sharp increase in the elimination of the isotope via the kidneys did not entail an increase in the absorbed dose in the kidneys and even reduced it within 6 to 12 hours by one order of magnitude compared with the kidneys of the controls. The administration of DTPA at a later stage such as after 24 hours and more since the administration of the isotope reduced more effectively the ^{65}Zn content of those organs and tissues in which the isotope builds up at a relatively slower rate. (M.M.B.)

22183 (AEC-tr-6944, pp 697-702) PRIMARY IMMUNIZATION AND REVACCINATION WITH LIVE BRUCELLOSIS VACCINE IN ^{210}Po-POISONING OF THE ORGANISM. L'vitsyna, G. M. Translated from pp 553-7 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The immune response in animals that are in contact with radioactive substances of low activity, i.e., when the course of radiation sickness is near-chronic, the immune response as a function of the period of time elapsed since poisoning with radioactive substances, and the features of the attendant response to primary and secondary contacts with bacterial antigens were investigated. The study was carried out on 120 guinea pigs of which 25 were subcutaneously injected with ^{210}Po in the dose of 0.5 μCi/kg. Another 25 were intraperitoneally injected with ^{90}Sr in the dose of 0.5 μCi/kg. The remaining 70 guinea pigs served as controls. The animals were immunized three, six and 12 months later with live brucellosis vaccine. Two months later the animals were revaccinated. Administration of ^{210}Po did not markedly affect antibody production on primary immunization. Revaccination with small doses of the vaccine altered the immune response in the radiation-poisoned animals. The immune response to the repeated administration of small doses of the brucellosis vaccine in ^{90}Sr-carrying animals was of nearly the same nature as in ^{210}Po-poisoned guinea pigs. Antibody production on reimmunization was two or three times as low as in the controls. The conducted investigation showed that comparatively small doses of radioactive substances (polonium and strontium) that do not yet lead to marked changes in the general state of the organism and produce only moderate changes in peripheral blood are capable of considerably altering the immune response of the organism. (M.M.B.)

22184 (CEA-CONF-1175) MATHEMATICAL TREATMENT OF METABOLIC DATA BY THE THEORY OF COMPARTMENTS. Bazin, J. P.; Marchadier, B.; Lafuma, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1968]. 13p. (In French). Dep.

From 1st European Congress on Radiation Protection and Exhibition on Equipment Using Low Energy and Short Range Radiation Dosimetry, Menton, France.

A Monte Carlo method for the mathematical treatment of metabolic data connected with the theory of compartments is derived. For a reasonable precision the cost of the Monte Carlo method is much below systematic sweep methods and it is about equal to that of the iterative methods presently used. (J.S.R.)

22185 (COO-1602-9) THE EFFECTS OF X-IRRADIATION ON STEROID BIOTRANSFORMATIONS BY TESTICULAR TISSUE. Technical Progress Report. Ellis, LeGrande C. (Utah State Univ., Logan. Dept. of Zoology). Feb. 4, 1969. Contract AT-(11-1)-1602. 42p. Dep. CFSTI.

A possible relationship between steroid metabolism and radiosensitivity of the testes was investigated in rats. Control and whole-body x-irradiated (450 R) rats were sacrificed from one to 32 days following exposure and steroid metabolites in excised seminiferous tubules and minced testicular tissues were characterized. The effects of localized x irradiation (1500 R) of the testes of young rats on steroid metabolism were also studied. Minced testicular tissue was incubated with ^{3}H-pregnolone and ^{14}C-progesterone for the purpose of comparing synthesis of testosterone and androstenedione in tissues from control and irradiated rats. Results showed that androgen synthesis was reduced as a function of time following irradiation, and it was concluded that this indicated the presence of radioinduced metabolic lesions within steroid biotransforming cells. Age appeared to be directly related to testicular androgen synthesis and radiosensitivity. (C.H.)

22186 (NYO-3086-8, pp III.1-18) REVIEW OF ^{210}Pb METABOLISM. Cohen, Norman; Howells, G. Parry (New York Univ., N. Y. Inst. of Environmental Medicine).

A summary of studies on metabolic processes influenced by lead kinetics is presented. These processes include intake, absorption, transport across the intestinal mucosa, transport in the body fluids from sites of absorption to tissues and to excretory sites, lead uptake by various tissues including deposition in bone, removal from sites of uptake and deposition, and excretion via the kidney, intestine, and other routes such as the hair and sweat glands. Studies on dogs, man, mice, and rats using ^{203}Pb, ^{210}Pb, and ^{212}Pb are reviewed. Extrapolation of data from rodents or dogs to man is questioned owing to differences in metabolism for bone-seeking isotopes by various species. The significance of ^{210}Pb metabolism studies in protection of exposed workers and effects of a polluted environment is pointed out. (H.L.W.)

22187 (NYO-3086-8, pp IV.1-33) METABOLIC STUDIES OF ^{210}Pb IN THE ADULT BABOON. Cohen, Norman; Howells, Gwynne Parry; Wrenn, McDonald E.; Eisenbud, Merril (New York Univ., N. Y. Inst. of Environmental Medicine).

Two baboons were injected intravenously with single doses of 60 μCi and 54 μCi of ^{210}Pb in isotonic saline solution. A scintillation counting system was used for in vivo measurement of radioactivity in the baboons. The design of a restraining chair that allows measurements to proceed without the use of anesthesia is described. A phantom skull was designed for estimation of approximate concentrations in the skull. Samples of blood, urine, feces, and hair were measured for ^{210}Pb by scintillation counting. Graphs are presented to show deposition and distribution of ^{210}Pb in bone and soft tissue as a function of time, in vivo measurement of ^{210}Pb in the skull, femur, kidney, abdomen, and chest as a function of time, and measurement of the biological half-time of ^{210}Pb in the blood. (H.L.W.)

22188 (NYO-3086-8, pp V.1-9) METABOLIC STUDIES OF ^{210}Pb IN THE RAT. Cohen, Norman; Cohen, Lawrence K. (New York Univ., N. Y. Inst. of Environmental Medicine).

Lead-210 was injected intravenously into 19 rats and scintillation techniques were used for determining distribution and retention. At intervals of 1, 3, 6, and 9 days after injection the animals were sacrificed; blood was removed by cardiac puncture and other tissues were removed and frozen for studies on transfer coefficients. Graphs are presented to show whole-body and blood radioactivity at various time intervals following injection. Values for activity in blood were obtained as a function of time that indicated a two-component model. The first component had a half-life of 30 hours and a second component with a longer half-life appeared to be present. (H.L.W.)

22189 (ORNL-4273(Summ.)) THE MOLECULAR ANATOMY PROGRAM (THE MAN PROGRAM). Second Biannual Progress Report, March 1, 1967-February 29, 1968. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. 57p. Dep. CFSTI.

The Joint NIH-AEC Molecular Anatomy (MAN) Program is concerned with the development of the biophysical tools required to dissect human cells to the molecular level, the application of these to current biomedical problems, and the systematic application of these tools to the problem of writing a molecular anatomy of human cells. During this report period, the major effort was the completion of the development of the K-II centrifuge and the application of it to the large-scale purification of commercial vaccines. For cell, tissue and plasma fractionation on a large scale, additional rotors (K-IV, V, and VI) were developed. This work provides a direct example of the research and development pattern being followed in the entire MAN program where a present requirement (in this case a purified vaccine) is used to evaluate and guide the evolution of a new system ultimately required for human cell fractionation. Using the K-V rotor, five gram samples of highly purified human α_2 macroglobulin were prepared for radiation protection experiments. In the smaller B series, rotors for rate zonal separations that may be either center or edge unloaded were developed (B-XXIII and B-XXIX). These were successfully applied to the problem of separating mitochondria, lysosomes, and peroxisomes. A rotor modification having a large center line, B-XV, was found useful for rate separations of DNA up to 130 million molecular weight. Theroretical and experimental studies are continuing on the development of gradients for the isopycnic banding and separation of quantities of human serum lipoproteins. A method was developed for isolating the membranes from brain synaptosomes. The isolation of cell surface membranes and transplantation antigens from these is of interest in connection with attempts to produce antitumor vaccines. An adenovirus 31 tumor membrane fraction was prepared that affords marked protection against subsequent tumor challenge. Studies on virus-like particles in human leukemic plasmas and in control sera using negative staining showed no correlation between the disease or treatment and particle incidence. Additional studies using sectioned pellets should be done. A group of low-speed rotors (A-XVI, XVII, and XVIII) were developed specifically for the isolation of nuclei in gram quantities. These rotors use either loading and reorienting gradients or dynamic loading and unloading with scoops in place of seals. The separation and analysis of cell macromolecules will require a number of analytical systems now under development, including an Edman protein sequenator (90% completed), a miniaturized amino acid analyzer, a nucleic acid sequenator, high resolution electron microscopy, and new techniques for automated enzyme assay. Reports concerned with the status of each of these are included. The development of analytical systems for low-molecular-weight organic (mesomolecular) compounds is centered chiefly on substances that absorb in the ultraviolet and on sugars. The problem chosen for emphasis is the analysis of human plasma and urine. High resolution systems capable of detecting up to 140 compounds in urine were developed and the systematic identification of these substances is continuing. Production of human cells for fractionation studies was started and will be scaled up as required. Design studies for a virus isolation and vaccine purification laboratory for the National Institute of Allergy and Infectious Diseases were started. Three conferences were held on the following topics: Centrifugal Techniques for Vaccine Purification, Viral, Tumor, and Transplantation Antigen Isolation, and Urinary Constituents of Low Molecular Weight. Planning network techniques, with or without computerization, are being adapted to the problem of planning and managing the MAN program. Reports are being revised to include only summaries and preprints of open literature or ORNL and ORGDP reports. (auth)

22190 (TID-24963) ROLE AND UTILIZATION OF ERYTHROPOIETIN IN STIMULATING ERYTHROPOIESIS. Three Year Report of Activities. ([Tennessee Univ., Knoxville]). [1968]. Contract AT(40-1)-3547. 22p. Dep. CFSTI.

Objectives of the study are to utilize fluorescein-conjugated antiserum to study the erythroid colonies of bone marrow transplanted mice; to supply concentrated erythropoietin and antiserum for studies of stem cell differentiation; to measure erythropoietin levels in irradiated mice; to measure the level of erythropoietin in functioning and hypofunctioning bone marrow suspension cultures; and to measure the effects of radiation on the iron uptake by bone marrow suspensions. Animal cages were covered with silicone rubber membranes; these were ideal for the production of hypoxia in mice since the oxygen level within the cage was found to be dependent on the number of mice enclosed. Studies were conducted on the incorporation of ^{59}Fe into erythrocytes, red cell mass, weight, and body water of enclosed mice. Experiments on production of antiserum to erythropoietin showed that there were two different antibodies, neutralizing and hemagglutinating. Evidence for the existence of these two types is described. It was found that the hemagglutination reaction could be inhibited by purified erythropoietin extracts in minute quantities and by much greater quantities of normal human serum. Since there was a linear relationship between the quantity of ESF and the amount which would allow hemagglutination in the inhibition reaction, a test system was set up in which a known amount of ESF was used as a standard. Experiments on virus-induced polycythemia in strain HAI ICR Swiss mice demonstrated erythropoietin-independent erythropoiesis. The mode of action of ESF in polycythemic mice was investigated using 5-fluorouracil. (H.L.W.)

22191 CLINICAL AND EXPERIMENTAL STUDIES ON VISUALIZATION OF THE SPLEEN IN LIVER SCAN. Yakushiji, Fusakuni (Kurume Univ., Japan). Nippon Shokakibyo Gakkai Zasshi, 65: 1097-1109(Oct. 1968). (In Japanese).

Using a color scanner and colloidal ^{198}Au, hepatic scintiscanning was performed in 600 patients with various diseases. Frequency and intensity of visualization of the spleen in patients with liver diseases, particularly in cirrhosis, hepatoma, and Banti's syndrome were studied. Different degrees of liver injury were produced in rats by injection of carbon-tetrachloride, as well as by the Campbell's immunological method. Several experimental studies were carried out on these rats to clarify the mechanism for splenic visualization. In normal rats, the ^{198}Au colloid clearance rate and hepatic uptake were not influenced by splenectomy. The hepatic uptake of colloid increased when the colloid was slowly infused into the portal vein, as compared with that after injection into the penile vein; the uptake of colloid by the spleen and bone marrow decreased slightly. After partial hepatectomy, colloid clearance rate was markedly impaired and spleen and bone-marrow uptake increased slightly; the hepatic per gram uptake increased considerably. In rats with advanced liver injury, the colloid clearance rate decreased in the same degree as in the partially hepatectomized rats and hepatic uptake of colloid decreased; the spleen and bone marrow of liver-injured rats were found to have a more markedly increased capacity to take up the colloid than in partially hepatectomized rats. This finding suggested that the spleen and bone marrow have a limited capacity for colloid uptake in the normal state. In rats with advanced cirrhosis, no difference was observed in colloid uptake by liver, spleen, or bone marrow when the colloid was injected into a mesenteric or peripheral vein. It was suggested that the spleen's capacity to clear intravascular colloids increased when liver disease was present and that this accounted for the increase in frequency and intensity of spleen visualization during liver scanning. (TSS) (NSA of Japan)

22192 THE TISSUE-BLOOD BARRIER AND DISRUPTION OF ITS PERMEABILITY TO ^{32}P IN CONNECTION WITH TRAUMATIC SHOCK. Serdarov, O. N. Zdravookhr. Turkm., No. 2, 15-18 (1967). (In Russian).

The permeability of tissue-blood barriers in connection with traumatic shock was studied by various methods (luminescent, radioisotope and histochemical) under the same experimental conditions. An analysis was made of the results of a study of the permeability of the tissue-blood barriers of the heart, lungs, liver, kidneys, spleen, hypophysis, adrenal glands, stomach, intestine, and brain for ^{32}P in various phases and degree of severity of the traumatic shock. The experiments were performed on rabbits and traumatic shock was evoked by the method of Cannon, modified by E. A. Asratyan and I. R. Petrov. The index of permeability was taken to be the ratio between the radioactivity of the tissue to the radioactivity of the blood taken immediately before the animal was killed, expressed in percentage. There were six series of experiments (20 animals in each series) and 1,560 analyses. The experiments showed that permeability was highest in the tissues of the liver, kidneys, cardiac muscle, adrenal glands and lungs, low in the spleen, stomach, intestine and hypophysis, and lowest in the brain. In the erectile phase permeability of the internal organs showed a sharp increase as compared to the same organs of control animals. In the torpid phase of first-degree shock there was a slight reduction in the radioactivity of tissue in all the organs investigated. The only exception was the spleen, where permeability increased 22.3% over the control. The second degree of severity was characterized by a reduction in permeability in all organs. There was a substantial reduction in penetrability in third-degree shock, and in fourth-degree shock the radioactivity of tissue dropped sharply. It was concluded that traumatic shock was accompanied by a two-phase generalized variation in the permeability of the tissue-blood barriers of internal organs and the brain: in the erectile phase—by an increase, and in the torpid phase—by a decrease. The reduction in the permeability of the biological barriers of various organs depends on the degree of severity of the traumatic shock. (JPRS)

22193 TURNOVER OF ^{109}Cd IN RATS. Lucis, Ojars J.; Lynk, Mary E.; Lucis, Ruta (Dalhousie Univ., Halifax, Nova Scotia). Arch. Environ. Health, 18: 307-10(Mar. 1969).

Distribution of subcutaneously injected ^{109}Cd was studied in mature rats over a period of 14 days. The isotope was primarily deposited in the kidneys, liver, and pancreas. Within four hours after injection, cadmium appeared in the wall and in the contents of the small intestine. In the colon and in its contents, the concentration of the isotope increased gradually over a period of 24 hours. Cadmium content in the intestinal tract decreased progressively between 30 and 336 hours after injection. The stomach wall concentrated and retained ^{109}Cd, and only traces of the isotope appeared in the contents of the stomach. From the blood plasma, cadmium disappeared rapidly, whereas the blood cells showed an increase in cadmium concentration between 24 and 336 hours after injection. (auth)

22194 EXPERIMENTAL STUDIES FOR THE EFFECT OF ^{95}Zr–^{95}Nb TO ALBINO RATS. III. DISTRIBUTION OF ^{95}Zr–^{95}Nb AMONG ORGANS MICRO-AUTORADIOGRAPHY OF LUNG ON INTRATRACHEALLY INTUBATED ALBINO RATS. Morishige, Toshiko (Kyushu Univ., Fukuoka). Nippon Eiseigaku Zasshi, 23: 400-5(Oct. 1968). (In Japanese).

Zirconium-95–^{95}Nb was administered to Wister rats by intratracheal intubation and time trends of distribution in organs as well as excretion in urine and feces were observed. In addition, autoradiography of the lungs was performed using the dipping technique. When ^{95}Zr–^{95}Nb was intubated into the lungs, a great amount was retained in and deposited into lung tissue 24 hours after administration; the amount decreased considerably after the 7th experimental day. It was observed that the amount of ^{95}Zr–^{95}Nb in the lungs at any time during the experimental period was greater than that for other organs. Sixty-three days after administration the deposition ratio of ^{95}Zr–^{95}Nb in the lungs was at the same level as that of bone. The amount of ^{95}Zr–^{95}Nb in the tibia increased considerably for 7 days and then began to decrease toward the final experimental day. The rate of decreasing radioactivity in the tibia was considerably slower after the 14th experimental day and the deposition ratio of tibia was the highest of any tissues except the lungs. When ^{95}Zr–^{95}Nb was administered into the body, it was considered that bony tissue had the strongest affinity of all tissues. After administration of ^{95}Zr–^{95}Nb, the largest amount was excreted in the feces the first 24 hours. Of the ^{95}Zr–^{95}Nb intubated into the lungs, 49.86% was excreted in the feces until the 63rd experimental day. Half of this amount was in the feces excreted 24 hours after administration. After that, the amount of ^{95}Zr–^{95}Nb excreted in the feces suddenly decreased and the difference in the amount between feces and urine gradually became less and less toward the final experimental day. Microautoradiography of lung tissue on the 63rd experimental day revealed that there were still a number of blackening spots caused by ^{95}Zr–^{95}Nb in the alveolar wall; some spots were also observed in cells in the wall. (TSS) (NSA of Japan)

22195 AUTORADIOGRAPHIC STUDY OF GENETIC TRANSFORMATION. Javor, George T.; Tomasz, Alexander (Rockefeller Univ., New York). Proc. Nat. Acad. Sci. U. S., 60: 1216-22(Aug. 15, 1968).

An autoradiographic method was used to visualize bacterial cells which have absorbed tritiated DNA during genetic transformation. The main conclusions of this study are as follows: in Pneumococcus the frequency of radioactive cells changes in parallel with the frequency of transformed bacteria. Under optimal conditions 100% of the individual cells may be competent (i.e., have the capacity to absorb DNA). Pneumococci in the competent state have a definite tendency to aggregate. In Bacillus subtilis the irreversibly absorbed DNA remains for some time localized either at one of the poles or at the center of the bacillus. Thus, it seems that the uptake of donor DNA molecules occurs at specific cellular sites. The average competent cell of B. subtilis is somewhat shorter than the average incompetent bacillus. (auth)

22196 LABILITY OF ^{3}H-RNA IN MONOLAYER CULTURES OF MOUSE EMBRYO CELLS AFTER ACID-FIXATION. Birnie, G. D.; Fox, Sylvia M.; Simons, P. J. (Imperial Cancer Research Fund, London). Exp. Cell Res., 53: 215-24(Oct. 1968).

A simple method for investigating changes in the metabolism of RNA and DNA in small numbers of cells in monolayer cultures was recently described. The cells were grown on small, sterile squares of stainless steel and RNA and DNA were labeled by incubating the cultures with ^{3}H-labeled nucleic acid precursors for 1 hr. The cells were fixed in situ with ice-cold trichloroacetic acid, followed by washing with ethanol-ether and ether, and air-drying. The amount of tritium which had been incorporated was measured with a windowless gasflow counter. It was noted that, when monolayer cultures were incubated with ^{3}H-thymidine, then acid-fixed and dried, the incorporated radioactivity was stable except to incubation with deoxyribonuclease. In contrast, a high proportion of incorporated ^{3}H-uridine was extracted when the acid-fixed monolayer cultures were incubated in an isotonic buffer solution. Since this observation suggested that a significant proportion of the cellular RNA might be readily eluted from acid-fixed monolayer cultures, the nature of this material and the conditions under which it was eluted from the acid-fixed cultures were investigated. It was established that the radioactivity eluted by buffer was in the cellular RNA and that this labile ^{3}H-RNA was a specific fraction of the labeled cellular RNA. (auth)

22197 SOME ASPECTS OF THE ASSIMILATION OF ^{99}Mo AND ^{86}Rb BY THE COMMON REED. Ilies, C. Celul. Hirtie, 17: 489-94(Dec. 1968). (In Rumanian).

In order to evaluate the application of the physiologically important microelements, such as B, Cu, Zn, Mn, and Cl, tracer experiments were carried out, using compounds containing ^{99}Mo and ^{86}Rb in the treatment of the common reed. The fibers with the rhizomes were immersed in a radioactive ammonium paramolybdate, $(NH_4)_6{}^{99}Mo_7C_{24} \cdot 24H_2O$, solution. After a certain time, the plants were dried, then calcined, and the radioactivity in the stem and leaves was determined. In the 77 to 150 cm plants, the radioactivity was found to increase first, and was followed by a decrease toward the apex; in the 190 to 250 cm plants, there was an initial decrease followed by an increase and then a sudden decrease. Most of the activity was again concentrated in the leaves, followed by the pods and the stem. The tests with ^{86}Rb were carried out using 6.6 and 1.8 mCi solutions of ^{86}RbCl. After 36, an activity increase from the bottom upward could be detected; the highest activity was encountered in the upper portion of the stem, followed by the leaves and the pods. (TTT)

22198 STUDIES ON PHAGOCYTOSIS. I. UPTAKE OF RADIO-IODINATED (^{131}I) HUMAN SERUM ALBUMIN AS A MEASURE OF THE DEGREE OF PHAGOCYTOSIS IN VITRO. Chang, Yi-han (Charles Pfizer and Co., Groton, Conn.). Exp. Cell Res., 54: 42-8(Jan. 1969).

A new method is described for measuring the phagocytic activity of polymorphonuclear leukocytes (PMN) from rabbit peritoneal exudate based on the uptake of external fluid during phagocytosis. The advantages of the method are discussed. (auth)

22199 RADIOCONTAMINATION OF THE ENVIRONMENT AND ITS EFFECT ON THE MOTHER AND FETUS. II. KINETIC STUDIES WITH LABELED BONE-SEEKERS IN PREGNANT AND LACTATING RATS. Sternberg, J.; Legare, J. M.; Marcil, B. (Univ. of Montreal). Int. J. Appl. Radiat. Isotop., 20: 81-95 (Feb. 1969).

The kinetics of calcium were studied in pregnant and lactating rats, as well as during fetal and neo-natal life, with the following findings: Pregnancy and lactation are accompanied by an acceleration of calcium kinetics; this concerns both accretion and resorption of bone calcium, which are slightly elevated during late pregnancy and markedly higher during lactation. The negative calcium balance can be ascribed to a higher parathyroid activity during these physiological situations. The slight negative calcium balance noted during late pregnancy is not sufficient to provoke the release of a bone-seeker trapped in the skeleton prior to pregnancy. On the other hand, the marked negative calcium balance during lactation is capable of releasing a bone-seeker from the skeleton and diverting it to the suckling through the milk. The presence of a feto-placental unit in the pregnant organism does not introduce a priority system in the metabolic pathway of calcium. A radiocontamination during pregnancy will result in a simultaneous deposition of the radioactive element in both mother and fetus, and it is not possible to alter the uptake of one system in favor of the other. Fetal deposition of bone-seekers cannot be reverted with any known hormonal or pharmacologic agent. During late fetal and early neo-natal life accretion is markedly higher than resorption, and both processes are significantly increased compared with maternal kinetics. The strong anabolic profile of early neo-natal life diminishes rapidly, the values in late sucklings being similar to those noted in young adults. The kinetic data obtained for calcium can be extrapolated within limits to other bone-seekers with a physiologic role similar to that of calcium; they cannot be applied to the rare earths, whose deposition in bones does not necessarily imply an accretion. (auth) (UK)

22200 REDUCTION AND ALKYLATION OF IMMUNOGLOBULINS FROM NORMAL, IRRADIATED, AND SPLENECTOMIZED RABBITS. Knight, Katherine (Indiana Univ., Bloomington). Contract Nonr. 3104(00); AT(11-1)-209. Proc. Soc. Exp. Biol. Med., 124: 1122-4(1967). (COO-209-141).

The L chain patterns of reduced and alkylated γ-globulin preparations from splenectomized, irradiated and normal rabbits were compared by starch gel electrophoresis. Animals irradiated with their spleen shielded produced γ-globulin with L chains similar to those of splenectomized and normal rabbits. Thus, the L chains formed in the spleen apparently do not differ electrophoretically from the L chains of γ-globulin formed in other organs. (auth)

22201 SENSITIVITY OF G_1 PHASE OF THE MITOTIC CYCLE TO CHROMOSOME ABERRATIONS INDUCED BY DAUNOMYCIN. Vig, B. K.; Kontras, Stella B.; Aubele, Audrey M. (Ohio State Univ., Columbus. Children's Hospital Research Foundation, Columbus). Mutat. Res., 7: 91-7(Jan.-Feb. 1969).

Cultured human leukocytes were exposed to three concentrations—0.01, 0.015, and 0.02 μg/ml—of the drug daunomycin during the period 0 to 24 hr before harvesting. In treatments lasting 22 hr or more, chromatid and chromosome breaks, dicentrics and exchanges were recovered. Treatments between 22-hr and 18-hr duration yielded higher frequencies of isochromatid type of aberrations than chromatid type. Aberrations were absent or very rare in cultures treated up to 14 hr. It was found that daunomycin does not cause mitotic delay of S or G_2 cells under the experimental conditions. Results indicate that the sensitive phase of the cell cycle to daunomycin is G_1, the chromatid aberrations and exchanges are the results of partial restitution of isochromatid breaks and illegitimate reunions, and different individuals react differently to the same concentration of the drug. (auth)

22202 PHOTOREACTIVATION OF ULTRAVIOLET LIGHT-INDUCED PYRIMIDINE DIMERS IN GINKGO CELLS GROWN IN VITRO. Trosko, James E.; Mansour, Virginia H. (Michigan State Univ., East Lansing). Mutat. Res., 7: 120-21(Jan.-Feb. 1969).

Haploid tissue cultures of the female gametophyte of *Ginkgo biloba* L. were maintained in the dark. Then, they were exposed to 2537 angstrom ultraviolet light. Following exposure, controls were incubated in the dark, while experimental samples received posttreatment with 3600 angstrom light. Finally, the DNA of the cells was analyzed for pyrimidine dimers by two-dimensional paper chromatography. Only those cells that received posttreatment with 3600 angstrom light were capable of monomerizing the pyrimidine dimers. (H.B.G.)

22203 THE EFFECT OF X RAYS ON THE DNA CONTENT OF MALIGNANT MELANOMA CELLS. Knoth, W.; Ehlers, G. (Univ., Giessen, Ger.). Arch. Klin. Exp. Dermatol., 233: 77-81 (Oct. 4, 1968). (In German).

Malignant melanomas of 4 patients were subjected to 50-kV x-ray doses of 3000, 6000, 9000, and 12,000 R. DNA contents of the cells were determined cytophotometrically, and compared with that of thymus lymphocytes. It was only after a total dose of 12,000 R, the highest dose used, that the cells of melanomas showed a decreased DNA distribution pattern similar to that found in resting nevus cells. Treatments with 3000, 6000, and 9000 R, on the other hand, showed no effect on DNA. (BBB)

22204 BODY-COMPOSITION METHODOLOGY IN MILITARY NUTRITION SURVEYS. Krzywicki, Harry J.; Consolazio, C. Frank. (Fitzsimons General Hospital, Denver). pp 492-511 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

Information has been presented on body density collected at three military installations. Potassium-40 counting has been presented only on personnel at Fort Carson. Data for total body water and anthropometric measurements are now undergoing automatic data processing. It is anticipated that regression or prediction equations that can utilize the data as predictors of body fat will be devised. Body density decreases with age, which represents an increase of body fat with age but is not related to body weight. The direct water-displacement volumeter is an excellent and simple device for measuring body density in the field and compares favorably with potassium-40 counting for estimating percentage of body fat. The fat-free estimates of 20- to 40-year-old males approximates 60.0 kg. (auth)

22205 DEUTERIUM-OXIDE DILUTION AS A PREDICTOR OF BODY COMPOSITION IN CHILDREN AND PIGS. Flynn, Margaret A.; Hanna, Fikri; Long, Charles H.; Asfour, R. Y.; Lutz, Ruth N.; Zobrisky, S. E. (Univ. of Missouri, Columbia). pp 480-91 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

In vivo estimations of total body water (TBW) by deuterium-oxide-dilution technique measure the same volumes that desiccation measures in young pigs. Total body water in 20 normal preschool children between 1 and 6 years of age was relatively constant at about 59% of body weight. Extracellular water did not stabilize to young adult levels of 26 to 27% of body weight until the second or third year of age. Intracellular water also took longer to stabilize, reaching a plateau at 32% of body weight by 3 years of age. Values for TBW and ECW for eight American and two Lebanese preschool children with simple undernutrition were significantly elevated upon hospital admission. When the children were fed an adequate diet for 10 weeks or longer, the values for body water compartments reached those for normal. On the basis of this study, measurement of thiocyanate space may be a valuable tool for early diagnosis of simple undernutrition. (auth)

22206 EXCHANGEABLE-POTASSIUM AND BODY-COMPOSITION MEASUREMENTS IN SHEEP. Fries, G. F.; Lynch, G. P. (Department of Agriculture, Washington, D. C.). pp 468-79 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

Potassium-42 and sodium-24 were used in studies carried out on sheep to determine the relation of exchangeable sodium, exchangeable potassium, and their sum to carcass composition of sheep. There was a high correlation between K_e and the carcass components, water and fat-free tissue. The sum $Na_e + K_e$ did not improve the prediction of these components. Secondary studies indicated that the estimate of K_e can be affected by diet. On the basis of this work, K_e shows promise as a predictor of carcass composition in living sheep. Because of the factors that may affect K_e, these measurements should be carried out under defined feeding conditions. Further work would be required to improve the accuracy of this method. (auth)

22207 ASSOCIATIONS OF BODY POTASSIUM, CHEMICAL COMPOSITION, AND CARCASS MEASUREMENTS WITH FAT-LEAN COMPOSITION DETERMINED BY PHYSICAL SEPARATION. Martin, T. G.; Stant, E. G. Jr.; Judge, M. D.; Christian, J. E. (Purdue Univ., Lafayette, Ind.). pp 428-51 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

In the swine data, correlations of grams of potassium per kilogram of sample with percentage of chemical constituents of various components were almost always higher when chemically determined potassium content was used than when counter-estimated potassium content was used. All correlations involving percentage of ether-extractable fat were negative. Potassium content of the total carcass was more highly correlated with the percentages of chemical constituents of the carcass than was potassium content of the muscle, bone, or fat with the percentages of chemical constituents in the respective component parts. Grams of potassium per kilogram of live pig was less highly correlated with physical separation estimates of composition than was grams of potassium per kilogram of carcass. Percentage of fat-free muscle in the carcass and percentage of carcass fat in the live pig were highly correlated with potassium concentration in the carcass. In the lamb data, multiple regression based on live and carcass weights, age, grams of potassium per kilograms of carcass and live animal, and total grams of potassium in the carcass and live lamb were found to yield virtually the same accuracy of prediction of percentage of edible portion in the carcass as did a multiple regression based on carcass measurements. Grams of potassium per kilogram of carcass was the primary predictor of percentage of edible portion in both the carcass and the live animal. Live weight, carcass weight, and total grams of potassium were primary predictors of edible-portion weight and excess-fat weight. Primary predictors of excess fat as a percentage of both the carcass and the live animal were fat-thickness measurements, and grams of potassium per kilogram of carcass and per kilogram of live animal. Predictions of carcass composition were considerably less accurate from data obtained on the live animal than from data obtained on the carcass. (C.O.)

22208 INDICES OF CHEMICAL COMPOSITION IN LIVE OVINES AND THEIR CARCASSES. Preston, R. L.; Hutcheson, D. P.; Hedrick, H. B.; Jeremiah, L. E.; Zobrisky, S. E.; Krause, G. F. (Univ. of Missouri, Columbia). pp 413-27 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

A total of 56 lambs (28 ewes and 28 wethers) were used to study several indices of ovine carcass composition. These indices included ^{40}K emission from the live animal as well as the carcass and several other direct and empirical measures of carcass composition. ^{40}K emission did not effectively predict carcass composition in either the live animal or the carcass. Several other carcass indices estimated carcass composition. Those with the highest reliability include percentage of fat trim, body wall thickness, retail yield, specific gravity of the 24-hr cold carcass, rib covering, omental fat as a percentage of wool-free empty-body weight, 24-hr cold carcass weight, kidney fat as a percentage of warm carcass weight, and warm carcass weight. The statistical parameters for each of these indices are included in this paper. (auth)

22209 COMPARISON OF THE ^{40}K METHOD WITH OTHER METHODS OF DETERMINING CARCASS LEAN MUSCLE MASS IN STEERS. Breidenstein, B. C.; Lohman, T. G.; Norton, H. W. (Illinois Univ., Urbana). pp 393-412 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

A total of 103 steers representing four breed types and slaughtered at four different weights were used in a study to compare several alternative methods of determining carcass lean muscle mass (CLMM). Fifty-four steers were subjected to whole-body counting after consuming a low-counting diet for a week. Constants for breed type were included in all regressions except those using whole-body potassium and physical measurements of the live animal. The dependent variable was weight or percentage of CLMM. The inclusion of either live weight or carcass weight in a regression model results in appreciable decrease in the coefficient of variation. Fat thicknesses measured at one half and three fourths of the medial to lateral axis of the longissimus were useful criteria, but little or no reduction in the coefficient of variation resulted from including fat thickness measured at one fourth of the medial to lateral axis. Inclusion of longissimus area generally reduced the coefficient of variation. Carcass specific gravity was a useful indicator of CLMM, and the coefficient of variation was further reduced by including carcass weight and fat thickness. Trimmed hindquarter was not better than other more easily acquired measures. Whole-body ^{40}K counting resulted in an appreciable reduction in coefficient of variation over other easily obtained measurements of the live animal, and carcass ^{40}K counting resulted in the lowest coefficient of variation of any regression model except that including standard trimmed lean. The model including standard trimmed lean had the lowest coefficient of variation of any model tested, 1.4%, and this was not reduced by including the fat thicknesses. (auth)

22210 PRECISION OF ASSAY OF WHOLE-BODY POTASSIUM IN MAN. Miller, Charles E. (Argonne National Lab., Ill.); Remenchik, Alexander P.; Kessler, Wayne V. pp 350-83 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

The results of analyses have demonstrated that the calibration factors for all whole-body counter techniques are dependent upon the weight of the subject; the single mathematical expression, $\log_{10}$ (G) = A + B(w_{kg}) will fit the curve of calibration factors obtained for subjects whose weights range from 43.88 kg to 157 kg; the actual calibration factor found for a particular subject may differ by as much as 10% from the value predicted by the regression line; the exchangeable K content of the body as measured by the isotope-dilution technique is very close to 92% of the total body K for all active subjects, including those who have starved for several weeks and lost considerable weight; the calibration factors and exchangeable K ratios obtained with the 7-crystal technique did not exhibit the variability observed with the other techniques; and every subject should be given ^{42}K in order to obtain the correct calibration factor for his body build, if very accurate K measurements are desired. (auth)

22211 ASSOCIATION BETWEEN CHEMICAL AND COUNTER ESTIMATES OF POTASSIUM CONTENT. Martin, T. G. (Purdue Univ., Lafayette, Ind.); Stant, E. G. Jr.; Kessler, W. V.; Parker, H. E. pp 341-9 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

Association between chemical and counter estimates of potassium content were high (r = 0.55 to 0.99) over a wide range of sample weights and total potassium contents. When restricted to narrow weight and total potassium content range, the correlation was drastically reduced. Either method will characterize group differences in potassium content. The two methods cannot always be depended upon to yield the same results in comparing two or more relatively similar samples. Accuracy of the chemical method appears to rely on sampling accuracy, whereas accuracy of the counting method depends on a sizable quantity of potassium and accurate calibration of the counter. (auth)

22212 FACTORS AFFECTING ESTIMATES OF POTASSIUM CONTENT BY WHOLE-BODY LIQUID SCINTILLATION COUNTING. Martin, T. G.; Harrington, R. B.; Kessler, W. V. (Purdue Univ., Lafayette, Ind.). pp 326-40 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

Twenty-seven cylinders containing a sugar–KCl mixture were constructed so that a 3^3 factorial arrangement of treatments was formed with three lengths (60, 113, and 166 cm), three weights (13.6, 40.9, and 68.2 kg), and three activity levels (100, 150, and 200 g of potassium). In addition, two standards were used to correct for day-to-day variation in counter efficiency. Over a short time span, the widely different standards were equally efficient in correcting for time changes in machine efficiency. However, the standards did not maintain this ability over a longer time span. Length, weight, and activity level all affected efficiency of detection of potassium content. The intermediate length (113 cm) was more efficient than either extreme. The effects of weight were curvilinear and, in all probability, followed the expected exponential curve. Increasing weight decreased efficiency of detection. The effects of activity level, though statistically significant, were of minor importance compared with the effects of weight and length. The interaction between length and weight indicated that the efficiency curves should correct for effects of both weight and length on efficiency of detection rather than for effects of weight alone. (auth)

22213 CALIBRATION TECHNIQUES FOR A CRYSTAL-TYPE WHOLE-BODY COUNTER. Johnson, J. E.; Ward, G. M.; Sasser, L. B. (Colorado State Univ., Fort Collins). pp 317-25 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

The technique of estimating in vivo body K by ^{40}K gamma-ray spectrometry has been shown to be feasible and sufficiently accurate in both swine and cattle. This technique has the advantage of measuring a body-composition component directly without the administration of radioactive isotope. The counter is calibrated from the counting rate of the animal, and the value of total body K is determined by atomic absorption spectrometry and ^{40}K gamma-ray spectrometry of all animal tissues after slaughter. The calibration procedure of ^{42}K dilution is also used. Once the counting calibration constant perfectly predicts total body K determined after slaughter, the instrument has been calibrated and can be used in studies relating total body K to body composition. (auth)

22214 FACTORS AFFECTING ^{40}K MEASUREMENT IN THE WHOLE BODY AND BODY COMPONENTS. Lohman, T. G. (Univ. of Illinois, Urbana); Coffman, W. J.; Twardock, A. R.; Breidenstein, B. C.; Norton, H. W. pp 291-316 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

Counter-induced and sample-induced variables were studied to determine what factors influence ^{40}K as measured by liquid scintillation whole-body counters. A comparison of day-to-day variation in detection efficiency by using a ^{137}Cs standard in two different whole-body counters indicated that fairly stable performances can be achieved, although observed variability probably due to electronic-instrument drift and photomultiplier-tube instability was significantly greater ($P < 0.05$) than nuclear decay variability. Consecutive counts over a 10-day period on a human subject yielded coefficients of variation of 2.7 and 1.8% for the two whole-body counters. Cattle were used to study the major sample-induced variables found to affect ^{40}K measurement, including diet as it influences the GI radioactivity, variability in positioning animals in the whole-body counter, body conformation, and breed type. By feeding a low-radioactivity diet for 7 days before ^{40}K counting and accounting for differences in body conformation, whole-body potassium predicted sum-of-parts potassium, as determined by ^{40}K counts on separate body components, with a SE of 3.4% and carcass lean muscle mass (CLMM) with a SE of 4.2%. Breed type affected the relation between whole-body potassium and sum-of-parts potassium significantly ($P < 0.05$) as well as that between carcass potassium and CLMM, but not that between whole-body potassium and CLMM. The effect of potassium found outside the lean tissue on the relation between whole-body potassium and carcass lean potassium and CLMM was also studied. Measurement of gamma radiation from intact carcasses was a more precise indication of whole-body potassium and of CLMM than measurement of radiation from separate carcass components. Intact carcass ^{40}K count, carcass mass, and three breed-type comparisons together predicted CLMM with a SE of 3.2%. (auth)

22215 ORGANIC SCINTILLATION DETECTORS AND THEIR USE IN THE STUDY OF BODY COMPOSITION. Anderson, E. C. (Los Alamos Scientific Lab., N. Mex.). pp 266-90 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

For the measurement of total potassium content of normal human subjects, large organic scintillation counters are capable of a precision of ±3 g of K (one standard deviation) under routine conditions. With special care, a precision of 1 g of K has been approached. The absolute accuracy may be comparable under favorable conditions, but the error can be larger than 8%. Sources of error include counting statistics, instrument instability, contamination, and calibration errors. General methods of detecting and evaluating these errors are discussed, and some results obtained with human counters are given. For the measurement of ^{40}K in normal human subjects in a 4-pi counter, the subject's weight is the only parameter necessary to define counting efficiency to an accuracy of a few percent, and nonuniformity of potassium distribution is not likely to cause significant errors. Methods of extending these estimates to larger animals are indicated. Animal measurements are undoubtedly more difficult because of the more serious problem with control of contamination and, in some cases, because of the larger mass. (auth)

22216 ESTIMATES OF BODY COMPOSITION DERIVED FROM POTASSIUM MEASUREMENTS. Remenchik, Alexander P. (Loyola Univ., Chicago); Miller, Charles E.; Kessler, W. V. pp 231-53 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

The estimation of body composition by means of potassium measurements and the general yet crucial assumptions (fat and water content of the body) on which they are based are discussed. Certain evidence bearing on these assumptions is reviewed and the appropriateness of these models in view of the review evidence is evaluated. (C.O.)

22217 ESTIMATION OF BODY COMPOSITION BY THE DILUTION OF HYDROGEN ISOTOPES. Panaretto, B. A. (Animal Research Lab., Prospect, Australia). pp 200-17 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

Estimation of body composition in relation to fat, protein, and water content by the dilution of hydrogen isotopes is reviewed. Consideration is given to man's body as well as those of large animals. Three principal areas of research that await development in the field of body composition in live animals are discussed. (103 references). (C.O.)

22218 DILUTION METHODS IN BODY-COMPOSITION STUDIES. Hansard, S. L. (Louisiana State Univ., Baton Rouge). pp 195-9 of Body Composition in Animals and Man. Washington, D. C., National Academy of Science, 1968.

From Body Composition Conference, Columbia, Mo. See CONF-670519.

The relative merits and the status of the various methods based on the dilution principle that is currently being employed for partitioning body composition of large animals are reviewed generally and discussed briefly. (24 references). (C.O.)

22219 BODY COMPOSITION IN ANIMALS AND MAN. Proceedings of a Symposium held May 4, 5, and 6, 1967 at the University of Missouri, Columbia. Publication 1598. Washington, D. C., National Academy of Science, 1968. 529p. (CONF-670519).

Fifteen separate abstracts were prepared for inclusion in NSA. In addition there were 19 other sections covering sections of the conference outside the scope of NSA; the sections were biology, statistics, densitometric methods, dilution methods, whole-body counting, and comparative evaluation of methods. (C.O.)

For abstracts of individual papers see: 22204–22218.

22220 CELLULAR RADIATION INJURY AND REPAIR. Brown, J. K. At. Energy Aust., 12: 18-23(Jan. 1969).

The manner in which tissue cultures and dose fractionation techniques lend themselves to studies of the nature of radiation injury are discussed. Particular chemical structures or cellular organelles that may be identified as the seat of damage are also discussed. It was concluded that the inactivation of mammalian cells by ionizing radiation was not wholly caused by injury to DNA; the explanations that the process of repair itself was radiosensitive or that some unidentified factor associated with cell division were offered. (C.O.)

22221 NEW TECHNIQUES TO STUDY NUTRIENT RELATIONS IN PLANTS. Bowen, G. D.; Rovira, A. D. (Commonwealth Scientific and Industrial Research Organization, Glen Osmond, Australia). At. Energy Aust., 12: 2-7(Jan. 1969).

Radioisotope-labeled phosphate (^{32}P), sulfate (^{35}S), chloride (^{36}Cl), and carbon dioxide (^{14}C) were used to study environmental factors affecting uptake, loss, and biochemical incorporation of labeled compounds along plant roots. The basic method consisted of recording sites of radioactivity along roots following radioisotope uptake from solutions; a gas-flow radiochromatogram scanner was used. Seedlings labeled with ^{35}S and ^{14}C were mounted on a 4-cm wide chromatography paper strip that was passed through the scanner. For ^{32}P and ^{36}Cl studies the seedling roots were attached to the paper by covering them with cellulose tape. The ^{35}S- and ^{14}C-labeled seedlings were attached by treating the paper strip with contact adhesive and then covering the roots with a thin polyethylene sheet. With optimal settings of collimator width on the detectors, speed of scanning, and integration time for the scale at which the sample was scanned, the resolution was better than 2 mm and radioactivity at any portion of the root was directly proportional to the area under the corresponding part of the scan, provided there was uniform self-absorption of radiation along the root. Information obtained with the method described is present on phosphate, sulfate, and chloride uptake along the apical 25 cm of main and lateral roots of soil-grown wheat; incorporation of ^{32}P-labeled phosphate along pine seedling roots; loss of inorganic ions from pine seedling root; and exudation of organic compounds from pine seedling roots. (C.O.)

22222 EFFECT OF IONIZING RADIATION ON EXCRETION OF THE BIOTRANSFORMATION PRODUCTS OF PYRIDINE COENZYMES IN RAT URINE. Benes, J.; Zicha, B. (Military Veterinary Research Inst., Prague). Physiol. Bohemoslov., 17: 587-600(1968).

Whole body exposure doses of 1,400, 1,000 and 600 R significantly increased the excretion of intermediary N^1-methylnicotinamide and 4-pyridone, the end product of biotransformation of pyridine coenzymes, in rat urine, 6-pyridone was excreted in trace amounts only. It was also found that N^1-methylnicotinamide and 4-pyridone were the main metabolites of catabolism of the nicotinamide adenine dinucleotide (NAD) molecule under physiological conditions. Nicotinamide-N^1-oxide and 6-pyridone were not demonstrated in the urine of the control rats without a nicotinamide or nicotinic acid load. The elaboration of a technique involving the use of ion exchange chromatography made it possible to determine several more nitrogenous metabolites in rat urine. Among these, the highly significant increase in the deoxycytidine level after exposure to x-rays was the most important finding from the aspect of the diagnosis of early postirradiation changes. The increase observed in N^1-methylnicotinamide and 4-pyridone excretion can thus be regarded as a further contribution widening the range of methods for the diagnosis of early postirradiation changes. (auth)

22223 CHANGES IN THE SUGAR AND AMINO ACID RATIOS IN COTTON AND CORN PLANTS AS A RESULT OF PRESOWING IRRADIATION OF SEEDS. Ibragimov, A. P.; Marfina, K. G. (Inst. of Experimental Plant Biology, Tashkent). Biochemistry (USSR) (Engl. Transl.), 33: 365-9(May-June 1968).

Translated from Biokhimiya, 33: 445-50(May-June 1968).

Presowing irradiation of cottom and corn seeds affects the distribution of the label from $^{14}CO_2$ among the various sugars and amino acids. The glucose, fructose, and sucrose contents in cotton and corn leaves increase with the radiation dose, while the relative content of radioactive carbon also rises (2-3-leaf stage). In the roots, the glucose radioactivity decreases, while sucrose activity increases relative to the control. The extent and nature of variations in the incorporation of a label into carbohydrates and amino acids depend on the radiation dose, and on the age and species of plant, and are different for different plant organs. (auth)

22224 STUDY OF THE HYDRODYNAMIC SIZE OF γ-IRRADIATED LYSOZYME BY GEL FILTRATION UNDER DIFFERENT CONDITIONS. Maksimov, V. I.; Osipov, V. I.; Kaverzneva, E. D. (Inst. of Organic Chemistry, Moscow). Biochemistry (USSR) (Engl. Transl.), 33: 370-5(May-June 1968).

Translated from Biokhimiya, 33: 451-8(May-June 1968).

The hydrodynamic properties of fractions I and II of γ-irradiated lysozyme were studied by gel filtration in different buffer systems. Fraction II (not precipitated by salting with 1 $\underline{M}$ NaCl in 0.1 $\underline{M}$ CH_3COOH) contains a mixture of molecules showing little change in conformation and possesses considerable enzyme activity (80%). Its structure is relatively stable, but differs from the structure of native lysozyme in local changes. Fraction I (precipitated by salting out with 1 $\underline{M}$ NaCl in 0.1 $\underline{M}$ CH_3COOH) is the fraction of γ-irradiated lysozyme with the most marked changes. Its low enzyme activity (5 to 7%), and the considerable changes in its hydrodynamic parameters under the influence of pH and ionic strength during gel filtration and salting out are evidence of profound disturbances of tertiary structure and loss of conformation stability of this fraction. γ-Irradiation of lysozyme increases aggregation of the enzyme molecules. Lysozyme is less susceptible to the action of radiation than ribonuclease A. (auth)

22225 THE INCORPORATION AND REMOVAL OF LARGE AMOUNTS OF STRONTIUM BY PHYSIOLOGIC MECHANISMS IN MINERALIZED TISSUES OF THE RAT. Johnson, A. R.; Armstrong, W. D.; Singer, Leon (Univ. of Minnesota, Minneapolis). Calcified Tissue Res., 2: 242-52(Nov. 15, 1968).

Two aspects of Sr metabolism were studied. First, the incorporation of Sr into bones and teeth from diets of known Sr, Ca, and P concentrations was studied in growing rats and second, the rates of removal of Sr from hard tissues containing large amounts of Sr were observed when the animals were fed a diet containing only a trace amount of Sr. The animals used were 21-day-old, male, Sprague–Dawley rats weighing between 40 and 50 g. In an otherwise satisfactory diet, an amount of Sr equimolar to that of Ca seriously debilitates the young growing rat and may culminate in death. The pathology owing to Sr was found by the methods used only in the hard tissues. The excess osteoid formed originally in the presence of large amounts of dietary Sr is removed during a subsequent period of feeding on a low Sr regimen. Removal of Sr from participation in physiologic processes appears to be of 2 types: excretion from the body and incarceration within the hard tissues. The translocation of Sr to the incisor teeth was demonstrated. Differences of Na and K contents of the hemimandibulae of the experimental and control groups were also observed. (BBB)

22226 EFFLUX OF ACCUMULATED CALCIUM FROM BRAIN MICROSOMES. Robinson, J. D. (State Univ. of New York, Syracuse). J. Neurochem., 15: 1225-35(Oct. 1968).

A microsomal preparation from rat brain accumulated ^{45}Ca by an ATP-dependent process during incubation in a hypotonic medium. Accumulation of ^{45}Ca was reduced in media containing 100 m$\underline{M}$ NaCl, 100 m$\underline{M}$ KCl, 100 m$\underline{M}$ choline chloride or 200 m$\underline{M}$ sucrose. During prolonged incubations NaCl further decreased ^{45}Ca content unlike the other ions; this suggested a release of accumulated Ca by NaCl. Microsomes that had accumulated ^{45}Ca during a prior incubation (preloaded microsomes) lost Ca during a subsequent incubation. NaCl specifically increased the rate of loss of ^{45}Ca. Ouabain had no effect on the NaCl-induced efflux. Loss of Ca from preloaded microsomes, both with and without NaCl, had a high temperature coefficient. Measurements of monovalent cation content showed no correlation of either the uptake or loss with a simple ion-exchange process and the accumulated Ca did not exchange with Ca in the medium. ATP specifically reduced the efflux of ^{45}Ca from preloaded microsomes. Although the diminished loss of ^{45}Ca could be attributed in part to reaccumulation, this was not the only mechanism since ATP also reduced the loss from continuously perfused microsomes preloaded with Ca. (BBB)

22227 ALLOGENEIC INHIBITION OF TRANSPLANTED TUMOR CELLS. Hellstroem, K. E.; Hellstroem, I. (Univ. of Washington, Seattle). Progr. Exp. Tumor Res., 9: 40-76(1967).

Some radiobiologic aspects of allogeneic inhibition of transplanted tumor cells are reviewed. Immunological reactivity against foreign isoantigens is depressed by sublethal doses of x irradiation (300 to 450 R). It was hypothesized that if allogeneic inhibition was caused by a primary immunological reaction of the F_1 hybrid hosts, it should be decreased by irradiation of recipient hosts prior to tumor inoculation. This was tested by transplanting small numbers of tumor cells to homozygous and F_1 hybrid mice, x irradiated with doses of 300 to 450 R the day before transplantation. Isoantigenic variant sublines, isolated in the A and A.SW strains from LNSF (A × A.SW F_1) lymphoma, homozygous lymphomas of the A and A.SW strains, and a sarcoma of C57BL origin, were used. Allogeneic inhibition could still be demonstrated in irradiated recipients. Neutralization experiments in which target cells were exposed to added lymphoid cells x-irradiated with doses up to 10,000 R indicated that the mechanisms responsible for allogenic inhibition are insensitive to x irradiation. In mice pretreated by repeated inoculations of test tumor cells which had been rendered incapable of multiplication by x irradiation with 12,000 R, attempts to increase or decrease allogeneic inhibition by the preimmunization procedures used were unsuccessful. Whether allogeneic inhibition could be attributed to in vitro contact between tumor target cells and cells from F_1 hybrid hosts was investigated. In neutralization experiments in which added lymphoid cells were x irradiated with 1000 to 1500 R or with doses up to 10,000 R it was consistently found that preirradiation of F_1 hybrid cells only slightly decreased their neutralizing capacity, and that untreated allogeneic lymphoid cells, which were slightly more growth-inhibitory than F_1 hybrid cells, decreased in neutralizing ability after x irradiation to the same level as that of untreated or x-irradiated F_1 hybrid cells. The demonstration that x irradiation of added lymphoid cells only slightly decreases their neutralizing effect suggests that neutralization is not the result of a primary immunological reaction. (BBB)

22228 KINETICS OF IMMUNE TOLERANCE TO HUMAN SERUM ALBUMIN INDUCED IN SUBLETHALLY X-IRRADIATED RABBITS. Nachtigal, D.; Greenberg, E.; Feldman, M. (Weizmann Inst. of Science, Rehovoth, Israel). Immunology, 15: 343-55(Sept. 1968).

The system of immune tolerance to human serum albumin (HSA) which is induced in rabbits by the administration of the respective antigen following 550-R total-body x irradiation was studied. Irradiation with 550-R does not result in a state of biphasic (two-zone) tolerance, like that apparently obtained with 400-R treatment, and no immune response could be elicited in this system with any dose of antigen administered according to a tolerance-inducing schedule. This type of induced unresponsiveness was found to be comparable with natural tolerance with regard to specificity and stability and was considered, therefore, a suitable experimental model. Kinetic studies revealed that tolerance can be induced in this system with small amounts of antigen which in nonirradiated animals would constitute small immunizing doses. This, however, depends on a proper schedule of antigen administration which has to be spread over the 8 weeks of postirradiation recovery, although tolerance could be induced by this method even when this antigen treatment was postponed as long as 4 weeks after x irradiation. Since the lymphoid system recovers rapidly from sublethal radiation injury, and since it was found that by the end of 4 weeks the lymphoid organs demonstrate good cellular repopulation, it was concluded that the 2 processes, namely that of lymphoid recuperation and that of transition from susceptibility to tolerance into the state of immunocompetence, progress independently. Some questions relevant to theories of the cellular basis of immune tolerance are discussed. (BBB)

22229 ISOANTIGENS AVAILABLE TO CIRCULATING ANTIBODIES. Witz, Isaac; Kaliss, Nathan; Pressman, David (Roswell Park Memorial Inst., Buffalo. Jackson Lab., Bar Harbor, Maine.). Contract AT(30-1)-2651. J. Immunol., 102: 283-7 (Feb. 1969).

Further studies on the availability of mouse DBA/2 isoantigens to circulating antibodies were made. Isoantibodies isolated from multiparous C57BL females (by DBA/2 males) exhibited in vivo localization in tissues of DBA/2 mice. A drastic reduction in the size of spleen by irradiation did not decrease the fraction of injected isoantibody that was fixed to this organ. Furthermore, the spleens of young mice, although rather small in size, fixed a maximal fraction of the injected isoantibody. Specific fixation of isoantibody by the livers of mice pretreated with immunosuppressive antisera was lower than fixation by the livers of mice treated with normal serum. This may be due either to competition for antigenic sites or to a specific action of the immunosuppressive antibody. (auth)

22230 STIMULATION OF IMMUNOGLOBULIN AND ANAMNESTIC ANTIBODY IN VITRO. Yashphe, Diane J.; Coons, Albert H. (Harvard Medical School, Boston). J. Immunol., 102: 306-16(Feb. 1969).

Fragments of lymph node from previously immunized rabbits were secondarily stimulated in vitro and placed under tissue culture conditions with the addition of ^{14}C-leucine to the culture media. Antibody synthesis as determined by incorporation of leucine began earlier than that detectable by passive hemagglutination. It was found that in such cultures the secondary antibody response was superimposed on a steady synthesis of immunoglobulin, possibly antibody directed against other antigens. (auth)

22231 INDUCTION OF COLICIN SYNTHESIS IN E. COLI BY X-IRRADIATION. Gumenyuk, V. A. (Central Inst. of Post-Graduate Studies, Moscow). Byull. Eksp. Biol. Med., 67: No. 2, 85-7(Feb. 1969). (In Russian).

The influence of x irradiation on colicin synthesis in five colicinogenic strains of *Escherichia coli* CA-7 (V), CA-18 (B), CA-23 (D), CA-53 (I), *B. freundi* (A) was studied. It was shown that x irradiation induced colicin synthesis in only two strains, in CA-23 (D) and to a lesser extent in CA-18 (B). Colicin synthesis began after 35 to 40 minutes and reached its maximum after 120 to 150 minutes of incubation in 37° after irradiation. The level of colicin in the medium and the magnitude in lacunae in the population after irradiation in the broth rose much faster as compared with irradiation in a synthetic media, but the maximum figures after irradiation under different conditions remained relatively the same. The colicin level in the medium after irradiation and subsequent incubation in the nutritive broth was much higher than when compared with irradiation and subsequent incubation in the synthetic medium. (auth)

22232 PROTEINS OF KERATIN AND THEIR SYNTHESIS. II. INCORPORATION OF [^{35}S] CYSTINE INTO PREKERATIN AND KERATIN PROTEINS. Frazer, I. E. B. (Wool Research

Organization of New Zealand Inc., Christchurch). Aust. J. Biol. Sci., 22: 231-8(Feb. 1969).

The presence within protein extracts from intact wool roots of a low-sulfur, non-microfibrillar protein masks the true specific activity values for microfibrillar proteins. As a consequence, the correct specific activity ratio of matrix to microfibrillar proteins at different time periods following a pulse of [^{35}S] cystine is also masked. Evidence is presented which indicates that the non-microfibrillar, low-sulfur protein, extractable with Lockes solution, contains subunits of microfibrillar proteins. It is proposed that such subunits polymerize to form the three-dimensional helical structure of the microfibrillar proteins within cells. The attainment of the complex structural form is not instantaneous, as indicated by a pronounced "lag" greater than 5 hr in the incorporation of [^{35}S] from a single pulse into microfibrillar proteins, as compared with matrix proteins in wool root cells. The incorporation of matrix proteins into protein-synthesizing cells occurs independently of microfibrillar protein synthesis. Though matrix proteins are incorporated faster into cells in the upper third of the prekeratin tissue than at lower levels, the results do not support a "two-stage" process of keratin synthesis. Microfibrillar proteins appear to be formed at much the same rate throughout the prekeratin tissue of wool follicles. (Australia)

22233 BLASTOMOGENIC ACTION OF POLYCAPROLACTAM DISCS AFTER γ-IRRADIATION OR THEIR ISOLATION WITH PARAFFIN. Pustogarova, G. A. (Research Roentgeno-Radiological and Oncological Inst., Kiev). Vop. Onkol., 15: No. 2, 75-7(1969). (In Russian).

Simultaneous implantation in the subcutaneous cellular tissue of each rat γ-irradiated, paraffined and intact polycaprolactam discs has demonstrated that isolation of the animal tissues from chemical action of polycaprolactam by way of covering discs with paraffin significantly reduced the rate of tumor incidence. Consequently, a direct chemical effect of polymers on the surrounding tissues is one of the causes of tumor development. (auth)

22234 DEUTERIUM SOLVENT ISOTOPE EFFECTS IN REACTIONS CATALYZED BY ISOCITRATE DEHYDROGENASE. Colman, Roberta F.; Chu, Rita (Massachusetts General Hospital, Boston. Harvard Medical School, Boston). Biochem. Biophys. Res. Commun., 34: 528-35(Feb. 21, 1969).

The result of substituting deuterium oxide for water on the rates of the overall and partial reactions catalyzed by the pig heart TPN-dependent isocitrate dehydrogenase was studied. Although the overall oxidative decarboxylation of isocitrate proceeds 4.9 times as fast in H_2O as in D_2O, the rate of the separately measured oxalosuccinate decarboxylation reaction is only 1.4 to 1.7 times greater in water. In contrast, the oxalosuccinate reduction reaction proceeds 5.0 times faster in H_2O. These results suggest that dehydrogenation is the slow reaction in the oxidative decarboxylation of isocitrate and that a proton transfer is involved in this rate-determining step. (auth)

22235 DNA CONTENT IN LIVER MITOCHONDRIA OF RATS OF VARIOUS AGE DURING REGENERATION AND WHOLE BODY X-IRRADIATION. Khanson, K. P.; Ivanova, L. V. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Vop. Med. Khim., 15: 64-6(Jan.-Feb. 1969). (In Russian).

DNA content in mitochondria of rat liver was investigated. It was shown that DNA content does not change with aging and amounts to 0.62 ± 0.03 mg per mg protein. Whole body x-irradiation in doses of 800, 1600, 3200 rad produced no substantial changes in this value. During regeneration of the liver after partial hepatectomy, an increase in the amount of mitochondrial DNA was noted; the maximum was reached 48 hours after the operation. The DNA increase in mitochondria was markedly depressed in whole body irradiation carried out 6 hours after the operation. (auth)

22236 RADIATION EFFECT ON DISTRIBUTION OF ^{14}C ABSORBED DURING PHOTOSYNTHESIS IN VARIOUS GROUPS OF ORGANIC SUBSTANCES. Marfina, K. G.; Ibragimov, A. P. (Inst. of Experimental Biology of Plants, Tashkent). Uzb. Biol. Zh., No. 6, 51(1968). (In Russian).

Effects of radiation on distribution of ^{14}C absorbed during photosynthesis were studied on the basis of data from pre-sowing of γ-irradiated seeds. It was found that in the labeled carbon dioxide atmosphere the distribution of ^{14}C was quite varied. Following irradiation of corn leaves and roots, a 222% increase of ^{14}C was found in the alcohol fraction of the leaves and a 180% increase in that of the roots. The radioactivity of the protein fraction varied slightly, while in the lipoid fraction the content of ^{14}C decreased with increasing radiation doses. In cotton leaves the carbon radioactivity is mainly concentrated in the aqueous and acid fractions. Irradiation resulted in an increase of radioactivity in these fractions as well as in the hydrocarbon fraction, but a decrease occurred in the albumin and lipoid fractions. The role of enzymes in radiation effects on photosynthetic reactions is discussed. (R.V.J.)

22237 EFFECT OF THYMECTOMY IN MODIFYING THE IMMUNOLOGICAL REACTIVITY OF XENOGENEIC RADIATION CHIMERAS. Ito, Akihiro; Ito, Takaaki; Takizawa, Shoichi; Yamasaki, Takao; Nishihara, Homi; Nishihara, Eimi; Yokoro, Kenjiro, Yokoro (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol., No. 9, 50-62(1968). (In Japanese).

The present study was undertaken in an attempt to elucidate the effect of neonatal thymectomy of the donor in minimizing an acute immunological reaction (acute graft-versus-host reaction) occurring after the xenogeneic hematopoietic cell transplantation in lethally irradiated recipients. The effect of adult thymectomy in the recipients was also studied on a small scale. Bone marrow or spleen cells from 7 week-old normal female or those of neonatally thymectomized rats of Wistar/Furth strain were transfused into 7 week-old female ICR/JCL mice (some of them had been thymectomized at 4 weeks of age) that had been irradiated with 850R of ^{60}Co gamma-rays a few hours previously. Their survival rates, histological and hematological changes were observed up to 30 days following the treatments. The obtained results are summarized as follows. Transplantation of the normal rat spleen cells into irradiated recipient mice was detrimental, and all mice of this group died within 15 days following the treatments. The early mortality could be reduced by the transplantation of spleen cells from neonatally thymectomized rats, but the eventual survival rate was similar to that of irradiated control mice. A better survival was observed among recipients of bone marrow cells, and the effect of the donor thymectomy was not apparent: the survival rates of both normal and thymectomized rat marrow recipients were similar throughout the experimental period. Adult thymectomy of the recipient mice gave no further effect in the 30 day survival as compared with that of non-thymectomized recipients. The establishment of the chimeric state was clearly demonstrated by the proliferation of granulocytic cells of rat origin which possess a strong alkaline-phosphatase activity in the peripheral blood and hematopoietic tissue of the recipient mice. Histological studies of the spleen of neonatally thymectomized rats revealed the atrophy of the lymphoid follicles with the depletion of small lymphocytes which are considered to be immunologically competent. This was supported by an observation that the number of hemolysin producing cells against the sheep erythrocytes was markedly reduced in these spleens as compared with those of the normal rats. In the bone marrow, on the other hand, no obvious difference in the cellularity and cell components was noted between normal and thymectomized rats. From these experimental results, it is suggested that the alleviation of the early mortality among recipient mice treated with spleen cells of rats thymectomized at birth could be attributed to the selective elimination of immunological competent cells (most possibly the small lymphocytes) in the donor tissue. This supposition is supported by the recent observations that the thymus plays an essential role during the neonatal period in the development and differentiation of lymphoid tissues and immunological reactivities. However, the role of the thymus appeared to be limited in breaking the strong histocompatibility barrier, such as xenogeneic combination, and no better survival than the bone marrow recipients could be obtained. (auth)

22238 ALLOGENEIC LYMPHOID CELL DISEASE IN MID-LETHALLY IRRADIATED CBA MICE: THE DELAYED HARMFUL EFFECTS OF SMALL NUMBERS OF C3H LYMPHOID CELLS. Barnes, D. W. H.; Mole, R. H. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 15: 43-50(July 1968).

A small number of allogeneic lymphoid cells may cause marked damage in recipients with depressed immune responsiveness, even when the antigenic differences are minor. Injection of 1000 C3H lymphoid cells into 9-month-old CBA mice irradiated with 750 rads increased mortality in the second to sixth months and after 18 months. In the first period there was a three-fold increase in syndromes attributable to lymphoid deficiency. Somatic mutation in lymphoid cells may be the explanation for delayed deaths during the second to sixth months following whole-body irradiation, when allogeneic cells have not been given. (auth)

22239 STUDIES ON THE WATER CONTENT OF VACCINIA VIRUS AND ITS HEMAGGLUTININ BY DENSITY GRADIENT CENTRIFUGATION. COMMUNICATION II. DETERMINATION OF THE SEDIMENTATION CONSTANTS OF VACCINIA VIRUS IN $CsCl–H_2O$ AND $CsCl–D_2O$ GRADIENTS. Schiek, Wolfgang (Univ., Goettingen, Ger.). Zentralbl. Bakteriol. Parasitenk., Abt. I Orig., 208: 363-71(Nov. 1968). (In German).

To study the influence of heavy water on the structure of vaccinia virus, the sedimentation constants were determined for H_2O- and D_2O-containing vaccinia virus in the $CsCl_2-H_2O$ and $CsCl-D_2O$ density gradients. The tests were carried out in 10-ml fractionation chambers made of acrylic glass with sector-shaped sedimentation space. For calculation of the sedimentation constants in the density gradients, determination of the viscosity of $CsCl-H_2O$- and $CsCl-D_2O$-solutions at +4°C dependent upon the salt concentration was necessary. The sedimentation constant for H_2O-vaccinia virus in the $CsCl-H_2O$-gradient was 7280 S. For D_2O-vaccinia virus in the $CsCl-D_2O$ gradient this value amounted to 8105 S. From these two values the sedimentation constants of 4588 and 4647 S, respectively, were calculated for the vaccinia virus suspended in water. Consequently, the volume of the virus is not essentially influenced by D_2O. The mean value for the sedimentation constants of the two gradient systems, reduced to normal conditions, (H_2O-vaccinia virus in H_2O) is 4618 S ± 30 S, and is in good accordance with the values reported earlier. (BBB)

22240 INFLUENCE OF VARIOUS CHELATING AGENTS ON ABSORPTION OF ^{60}Co, ^{59}Fe, ^{54}Mn AND ^{65}Zn BY CHICKENS. **Suso, F. A.; Edwards, Hardy M. Jr. (Univ. of Georgia, Athens). Poultry Sci., 47: 1417-25(Sept. 1968).**

The effects of feeding different levels of ethylenediaminetetraacetic acid (EDTA) and other chelating agents on the absorption of ^{60}Co, ^{59}Fe, ^{54}Mn, and ^{65}Zn by chickens were determined using whole-body counting techniques. Absorptions of ^{60}Co and ^{59}Fe, radioactive isotopes of elements of groups VIII B, were decreased as the levels of chelating agent increased from 0 to 0.24% of the diet. However, ^{65}Zn absorption was significantly increased as the levels of EDTA were increased from 0 to 0.165% of the diet, attaining maximal absorption at 0.125% EDTA. The 0.19% EDTA level did increase absorption slightly. A similar absorption pattern of ^{54}Mn was seen as levels of EDTA ranged from 0 to 0.24% reaching maximal absorption at 0.18%; however, these levels increased ^{54}Mn absorption but the values were not statistically significant. Additions of different chelating agents to corn-soy diets did not show a direct relation between stability constants and absorption levels of ^{60}Co, ^{59}Fe, ^{54}Mn, and ^{65}Zn, but a relation between stability constant, levels of sequestrene in the diet and absorption of radioisotopes was suggested. (BBB)

22241 LABELING OF MARROW CELLS OF VITAMIN E-DEFICIENT MONKEYS BY ^{3}H-PRECURSORS OF NUCLEIC ACIDS AND PROTEIN. **Hanna, Calvin; Neufeld, Orville G.; Fitch, Coy D. (Univ. of Arkansas, Little Rock). Proc. Soc. Exp. Biol. Med., 130: 167-71(Jan. 1969).**

The incorporation of ^{3}H-labeled thymidine, deoxyuridine, uridine, and *l*-leucine into bone marrow cells of vitamin E-deficient and control monkeys was measured in autoradiographic studies. During the anemia of vitamin E-deficiency there was an increase in the grain count per labeled cell of most cell types in the erythroid and myeloid series, while the percentage of ^{3}H-labeled cells was not altered from control values. Multinucleated erythroid cells in the bone marrow of vitamin E-deficient monkeys were not labeled by thymidine-^{3}H. These findings are evidence that active erythropoiesis associated with premature death of erythroid cells occurs in the hypercellular bone marrow of anemic vitamin E-deficient monkeys. (auth)

22242 EFFECT OF HEAVY WATER ON THE THERMAL RESISTANCE OF MICROORGANISMS. **Jung, Klaus (Institut fuer Stabile Isotope, Leipzig). Stud. Biophys., 4: 125-33(1967). (In German).**

The survival and heat tolerance of Escherichia coli was compared in nutrient media that contained either H_2O or D_2O with 98.6% of D. At temperatures between 25 and 50°C growth inhibition effects of the D_2O decreased as the temperatures were increased. Below 48° the effect was relative, but above 48° the effect was small but definite. At 52 and 55° thermal tolerance was considerably increased in the D_2O-media. At 52° the numbers of surviving cells differed by a factor of 10^5 after 6 hr, but at 55° after 2 hr the factor was only 10^2. The release of an uv absorbing material by the bacteria was decreased considerably in D_2O-media following incubation at 52° for 60 min. There were no differences in the uv absorption of the cells from the D_2O-media as compared to those from the H_2O-media. The amounts between 220 and 360 mμ of amino acids, RNA, and DNA that were extractable from the cells grown on D_2O-media were markedly less than the amounts extractable from H_2O cultures of E. coli. The results may have been related to stabilizing effects of the D_2O on the protein molecules of the cells. (BBB)

22243 EXPERIMENTS ON THE ABSORPTION OF RADIOACTIVELY LABELED MATERIALS BY EXTRACTED HUMAN TEETH. Koenig, Hans (Blendax-Werke GmbH, Mainz). J. Soc. Cosmet. Chem., 19: 769-83(Nov. 11, 1968). (In German).

The absorption of ^{18}F (as NaF, LiF, and LiNa(PO_3F)), ^{45}Ca (as $CaCl_2$), ^{54}Mn (as $MnCl_2$), ^{32}P (as KH_2PO_3 and adenosinetriphosphate), and ^{48}V (as $Na_4(H_2V_4O_{13})$) by extracted human teeth was studied. The teeth were kept in the solutions at pH 6 to 7 for 20 min at 20°C. It was shown that such nuclides can penetrate deeply into the central portion of the teeth. Long-term experiments demonstrated that physiologically important substances are to some extent irreversibly retained in the teeth. From experiments with solutions of different concentrations, it was concluded that these processes are not exclusively physical diffusion and absorption phenomena, which are concentration dependent and reversible. Instead, additional irreversible and concentration independent processes take place. Deposition in crystal lattices by occupation of lattice defects is probably involved. (BBB)

22244 EFFECTS OF ACUTE IONIZING RADIATION ON INCORPORATION OF ^{131}IUDR BY COTTON RATS, SIGMODON HISPIDUS. **O'Farrell, Thomas P.; Dunaway, Paul B. (Oak Ridge National Lab., Tenn.). Radiat. Res., 38: 109-24(Apr. 1969).**

Acute gamma irradiation affected the incorporation of the thymidine analog 5-^{131}iodo-2'-deoxyuridine (^{131}IUDR) by cotton rats, Sigmodon hispidus. Absorbed doses of 100, 500, and 1000 RADS administered 24 hours before injection depressed whole-body measurements of radioactivity retained at 48 hours postinjection to 76%, 38%, and 28%, respectively, of control values. The greatest depression of total activity retained within tissues occurred in the intestines, where activity levels were reduced to 47%, 18%, and 1.5% of control values. Since the data included responses from maximum incorporation in controls to minimum incorporation in animals irradiated at 1000 RADS, a regression of activity remaining in the intestines as a function of total body burden was calculated to interpolate responses at intermediate dose levels. The in vivo measurements were a useful index to radiation insult at doses below 1000 RADS. The method described should serve as a valuable adjunct to other techniques for measuring the effects of ionizing radiation in free-ranging mammals at dose levels that are too low to induce gross pathological responses or death. At the highest dose, activity accumulated in the excretory pathways and the gastrointestinal contents; the latter may have been due to a delayed emptying syndrome of the tract. (auth)

22245 ACID PHOSPHATASE IN LENS EPITHELIUM OF RABBITS AFTER X-IRRADIATION. **Richards, R. D.; Schocket, S. S.; Michaelis, M. (Univ. of Maryland, Baltimore). Radiat. Res., 38: 140-52(Apr. 1969).**

Acid phosphatase, a lysosomal enzyme, is present in the normal lens epithelium of rabbits, with the greatest concentration in the germinative zone. No change in the acid phosphatase concentration is seen in histochemical whole lens epithelium preparations by 7 days after exposure to 2000 RADS of x ray (cataractogenic dose). A marked decrease is seen in the germinative zone at 28 days after exposure, with progressively greater decrease at 42 and 60 days. The decrease is due in part to fewer acid phosphatase granules in the individual cells in the germinative zone and in part to cell depletion. (auth)

22246 THE CYTOPLASMIC RNA OF HELA CELLS: NEW DISCRETE SPECIES ASSOCIATED WITH MITOCHONDRIA. **Vesco, Cesare; Penman, Sheldon (Massachusetts Inst. of Tech., Cambridge). Proc. Nat. Acad. Sci. U. S., 62: 218-25(Jan. 1969).**

Two new species of cytoplasmic RNA with approximate sedimentation values of 12S and 21S, and that appear associated with mitochondria, are described. The species are unmethylated, are relatively metabolically stable, and have a 43 per cent G + C content. Their synthesis is uniquely resistant to inhibition by uv irradiation. The 12S and 21S RNA do not appear to be components of polysome-like structures. (auth)

Ecology

Refer also to abstract 22302.

22247 (AEC-tr-6944, pp 215-21) EFFECT OF CALCIUM IN DRINKING WATER ON ^{90}Sr BUILD-UP IN THE BONY TISSUE OF THE ADULT POPULATION. **Karmaeva, A. N.; Knizhnikov, V. A.; Marei, A. N.; Moiseenko, E. I. Translated from pp 167-72 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.**

The effect of extra calcium in drinking water on the ^{90}Sr content of the bones of the population using the water was examined. A town's population consisted of two groups, each receiving water from a different water source containing a different proportion of calcium. In all other respects these groups did not differ. Their normal diet was the same. The calcium content of the daily diet of both population groups was adequate and even somewhat exceeded the official Soviet standards. Strontium-90 build-up in the bones of the population was determined by means of radiochemical analysis of specimens of the thoracic bone taken from the cadavers of adults who had lived in the town for more than five years and who had died suddenly, chiefly owing to acute cardiovascular deficiency or an accident, during the period from June 1962 until March 1963. The water supply source was identified by checking the address of the deceased. Bones of persons who had lived in the district with combined water supply were not taken for analysis. Calcium was determined by the permanganatometric method. Strontium-90 analysis in the bone ash and water was accomplished by the extraction and nitrate methods. Fluorine analysis was performed by the zircon-alizarin method. The 108 cadavers from the district with high calcium in the water supply (101.3 ± 10.6 mg/l) had lower (83%) ^{90}Sr content in their bones than the 51 cadavers (100%) from the district with low calcium (34.5 ± 4 mg/l) in the water. The bones of the males had a higher average ^{90}Sr content than those of the females. (M.M.B.)

22248 (AEC-tr-6944, pp 227-34) EFFECT OF VARIOUS SALINE COMPOSITIONS OF WATER ON THE BUILD-UP OF ^{90}Sr AND ^{137}Cs IN FRESHWATER FISH. Lebedeva, G. D. Translated from pp 176-81 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effects of high concentrations of stable isotopes in water on the ^{90}Sr content of Leucaspius delineatus bones and the ^{137}Cs content of the tissues were studied. Various concentrations and combinations of salts of Sr, Ca, Mg, and P were added to aquaria filled with 70 liters of ^{90}Sr solution ($1 \pm 0.2 \times 10^{-7}$ Ci/l) and salts of stable isotopes of K and Na to aquaria filled with ^{137}Cs ($1 \pm 0.2 \times 10^{-7}$ Ci/l). Initially the aquaria were renewed daily and subsequently every three days until the end of the experiments (three to four months). Periodically fish were removed for analysis. Tissues were calcined and the ash was counted with a B-type counter. The most significant reduction in ^{90}Sr build-up in the skeleton (by a factor of 5 to 10) was accomplished chiefly by adding stable Ca in an amount (of from 150 to 520 mg/l) 5 to 10 times as high as its natural content in Moscow tapwater. The penetration of ^{137}Cs into the tissues may be reduced two to seven times by treating water with such elements as potassium and sodium. Within the limits of our experiment the addition of extra amounts of the stable isotopes named above did not produce any appreciably harmful effect on the fish. The findings may be utilized to calculate the maximum permissible concentrations of radioactive Sr and Cs in the water of open-water reservoirs. (M.M.B.)

22249 (ORO-2412-16) RADIATION ECOLOGY STUDIES. Progress Report, January 1968–January 1969. Platt, Robert B. (Emory Univ., Atlanta, Ga.). Contract AT(40-1)-2412. 48p. Dep. CFSTI.

Studies on the ecology of Panola Mountain included determination of soil moisture content, soil composition, and radionuclide content of plant species. A map was prepared to show distribution of major soil islands, forested communities, and drainage patterns across the granite outcrop. Investigations were conducted on the fungal ecology of granite outcrops of the southeastern Piedmont. It was found that the growth of Penicillium frequentans was maximum on fresh Confederate Daisy (Vigiuera porteri) and minimum on old Loblolly Pine (Pinus taeda) needles. For Rhizopus nigricans, growth was maximum on fresh St. John's Wort (Hypericum gentianoides) and minimum on old pine litter. For Trichoderma viride, growth was maximum on fresh Vigiuera and minimum on old Red Cedar litter (Juniperus virginiana). The effects of microtopography and microweathering of granitic rock on the distribution of saxicolous plants were studied. Investigations were conducted on the effects of periodic exposure to gamma radiation on a typical life system (Triticum vulgare). After exposure, the seeds were soaked in distilled water and at 24, 48, and 72 hrs the coleoptile, primary root, lateral roots, leaf, and root hair origin lengths were measured as mm of growth. Results are tabulated. Studies were conducted on osmoregulation in the intramarsupial and newly shed young of the estuarine isopod, Cyathura polita. Results indicated that extreme salinities had important effects on rate of development, hatching, and the general developmental pattern. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstract 22305.

22250 (AEC-tr-6944, pp 410-20) MORPHOLOGICAL AND CYTOLOGICAL CHANGES IN THE CELLS OF THE PERIPHERAL BLOOD AND BONE MARROW OF MICE CHRONICALLY POISONED WITH ^{90}Sr. Panchenko, I. Ya.; Grebenyuk, N. G. Translated from pp 322-30 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

In genetic-line mice chronically poisoned with ^{90}Sr in concentrations of 3.5×10^{-10}, 3.5×10^{-9}, 3.5×10^{-8} and 3.5×10^{-7} Ci per mouse daily, statistically reliable changes in indicators of peripheral blood ($p < 0.05$) were observed in animals of group 4 of every line after six months of poisoning and were characterized by depression of hemopoiesis. The changes in the indicators of peripheral blood and the chromosomal injuries to the bone marrow cells were of a surge-like nature. In the later stages of poisoning animals in groups 3 and 4 of the lines investigated displayed deep-seated pathological changes (agglutination of chromatin into lumps, cell disintegration, formation of binuclear elements). The radiosensitivity of the genetically different mouse lines with respect to ^{90}Sr differs. Mice of the BALB and CC_{57} Brown lines proved to be the most radiosensitive, followed by mice of the C_{57} Brown line. Mice of the A line displayed the lowest radiosensitivity to radioactive strontium. (tr-auth)

22251 (COO-1404-7) COMPARATIVE RADIOSENSITIVITY STUDIES IN THE GRAMINEAE. Final Report. Boyle, W. S. (Utah State Univ., Logan). 1968. Contract AT(11-1)-1404. 6p. Dep. CFSTI.

A sterile triploid hybrid between Agropyron cristatum and A. subsecundum was x-irradiated and treated with colchicine. Attempts to produce a fertile hexaploid from a sterile triploid were not successful. Grass hybrids were subjected to acute doses of x rays ranging from 1 to 8 kR. The hybrids were Sitanion hystrix X Agropyron trachycaulum, Agropyron cristatum X Agropyron subsecundum, and Agropyron trachycaulum X Hordeum jubatum. As measured by mortality, growth inhibition, and dry weight, the hybrids were strikingly and consistently more resistant to the higher doses of radiation than were their parents or any of the species studied. Little or no correlation was found between type and level of polyploidy and sensitivity to acute x radiation, as measured by mortality, growth inhibition, and dry weight production in the following species of Triticeae: Agropyron cristatum, A. desertorum, A. trachycaulum, Hordeum jubatum, and Agrohordeum macounii. Radiosensitivity was not closely related to average interphase chromosome volume in these species. Average metaphase chromosome volume as an index of radiosensitivity was studied using rye, wheat, and barley. (H.L.W.)

22252 SELECTION EXPERIMENTS ON IRRADIATED MAIZE POPULATIONS. Palenzona, D. L. Maize Genet. Coop. News Lett., 41: 13-15(Apr. 15, 1967).

Results of x irradiation of maize tassels with doses of up to 3000 R were studied in three selfed successive generations. The number of internodes below the highest ear increased with dose, while the number of tassel branches and the total length of internodes below the highest ear both decreased. In the minus direction of selection these characteristics tended to increase with dose. The results suggested that the phenotypic expression selected for did not correspond to the genotypic value of the plants. The genetic variability seemed to result mainly from epistatic and dominance effects. The decrease of the mean value with the irradiation dose observed in selections for the population mean suggested that the deleterious effects of the radiations were also produced when the male gamete was treated. The deleterious effects may have been due to mutations transmitted and retained in later generations after irradiation and inbreeding, showing heterotic effects. (BBB)

22253 IZBRANNYE TRUDY. II. DEISTVIE IZLUCHENII NA MIKROORGANIZMY I EKSPERIMENTAL'NYI MUTAGENEZ. (Selected Works. II. Action of Radiation on Microorganisms and Experimental Mutagenesis). Nadson, G. A. Moscow, Izdatel'stvo Nauka, 1967. 264p.

This second part of G. A. Nadson's collection of works is concerned with radiation effects on living organisms. The effects of x radiation on sexual reproduction and occurrence of mutations in the lower fungi, Mucoraceae, are discussed. The effects of x radiation and γ radiation (radium) on acceleration and premature presinilation of life processes are also discussed. Anomalous sexual processes in Nadsonia fulvescens yeast that were x radio-induced and the development of new x radioresistant strains of Sporobolomyces and Saccharomyces cerevisiae, that undergo mass sporulation are described. Excitation effects of uv radiation on the development of yeasts, molds, and Bacillus mycoides Fl., effects of x radiation on the protoplasm and nuclear material of the growing cell that were observed in vivo, and the effects of uv radiation on chlorophyll-containing microorganisms are discussed at length. The effects of metal ions on the physiological and genetic processes of the Endomycetaceae; the transmission of hereditary factors responsible for ameba-shape formation in yeast, and sexual recombination processes of microorganisms are covered in the last few chapters. An extensive reference list is included. (R.V.J.)

22254 ACTINOMYCIN D: INHIBITION OF CHROMOSOMAL REPAIR IN HUMAN LYMPHOCYTES. Prempree, T.; Merz, T. (Johns Hopkins Univ., Baltimore). Mutat. Res., 7: 126-8(Jan.-Feb. 1969).

Cultures of human lymphocytes were exposed to 300 R x radiation given either in a single dose or in two half doses separated by various time intervals. When actinomycin D is added to the culture medium during the interval, the normally occurring repair of radiation induced chromosomal breaks was not observed. (H.B.G.)

22255 X-RAY-INDUCED MULTIPLE ABERRATIONS AMONG OOCYTES OF DROSOPHILA MELANOGASTER. Rinehart, Robert R.; Ratty, F. J. (San Diego State Coll., Calif). Mutat. Res., 7: 122-5(Jan.-Feb. 1969).

Drosophila melanogaster females were exposed to 3000 R x radiation and then, mated with three to four day old males. Observations were extended throughout ten generations. Chromatid interchanges induced in germ cells were detected phenotypically. Both the relative frequency of interchange and the chromosomes involved were determined. (H.B.G.)

22256 PHENOTYPE AND KARYOTYPE OF A CULTURED CHINESE HAMSTER CELL LINE DEFECTIVE FOR ULTRAVIOLET LIGHT RESISTANCE. Todd, Paul W.; Hellewell, Andrew B. (Pennsylvania State Univ., University Park). Mutat. Res., 7: 129-32(Jan.-Feb. 1969).

Cell cultures exposed to ionizing radiation or other mutagenic agents produced defective cell lines that were characterized by multiplication rate, increased sensitivity to ionizing radiation and generally, normal resistance to ultraviolet light. Such a defective cell line of Chinese hamster cells was exposed to various amounts of ultraviolet radiation; surprisingly, increased sensitivity was demonstrated. Karyotype analysis showed that the defective line lacks at least one chromosome. (H.B.G.)

22257 CLASSIFICATION OF RADIOINDUCED CHROMOSOME ABERRATIONS. Bauchinger, M. (GSF Munich, Neuherberg, Ger.). pp 141-3 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Ionizing radiation induces two types of disturbances in the cell nucleus: aberrations of chromatid and changes in chromosomes. During interphase, chromosome damage occurs within the DNA doubling period; chromatid deviations follow the synthetic phase. Based on these fundamental facts, a classification of radioinduced cell changes is presented. (H.B.G.)

22258 MUTANTS WITH ALTERED DNA-BASE COMPOSITION. van der Plaat, J. B.; Apontoweil, P.; Berends, W. (Technological Univ., Delft, Netherlands). Mutat. Res., 7: 13-18(Jan.-Feb. 1969).

The base compositions of DNA's from Bacillus subtilis 168, Bacterium paracoli 5099 and from mutants and other strains related to these bacteria have been determined. The degree of DNA homology between these strains has been calculated from DNA hybridization experiments. The results show that so-called mutants with altered DNA composition are not related to their respective parent types. They also support a recent report that the mutant indicated as B. paracoli 1975 belongs to the genus Flavobacterium. This mutant also has much genetic information in common with another mutant described in the literature, UV2, with altered DNA composition and stated to have been isolated from Staphylococcus aureus 209. Attempts to repeat mutation experiments with B. subtilis and B. paracoli as described in the literature did not yield mutants whose DNA-base composition was found to be altered. (auth)

22259 X-RAY-INDUCED MUTATIONS IN THE POECILIID FISH, LEBISTES RETICULATUS PETERS. Schroeder, Johannes Horst (Society for Radiation Research, Neuherberg, Ger.). Mutat. Res., 7: 75-90(Jan.-Feb. 1969).

The genetic effects of X-irradiation in male and female germ cell stages of the poeciliid fish Lebistes reticulatus were investigated. A hybrid and an inbred line were chosen as experimental material. In both hybrid and inbred lines, litter size increased in the progeny of irradiated parents in the generations following irradiation. The frequency of still births and post-natal mortality were reduced in all the post-irradiation generations of the inbred line and increased significantly in the F_2 generation after spermatogonial irradiation with 1000 R in the hybrid line. Sex-ratio was little affected. The incidence of individuals with hereditary curvature of the vertebral column and of guppies with mutations of the basic pigmentation of the body was higher in the post-irradiation generations. The mutation rate calculated from these findings lies below that of the house mouse. (auth)

22260 GENETIC EFFECT OF IRRADIATION BY X-RAYS ON SEEDS OF ZEA MAYS. INFLUENCE OF HIGH-TEMPERATURE TREATMENT BEFORE THE IRRADIATION ON THE IMMEDIATE EFFECT. van de Walle, C. (Univ., Liege). Mutat. Res., 7: 35-42(Jan.-Feb. 1969). (In French).

Seeds of Zea mays with a special genetic constitution are used to study the biological effects of x rays. In one strain, embryos are heterozygous for the yellow-green gene on chromosome 9 (Yg_2/yg_2). In the other strain, embryos are hypoploid; the short arm of one chromosome 9 is lost, and only one dominant yellow-green allele is present ($Yg_2/-$). Irradiation produced somatic mutations in the leaves of the seedlings due to the loss or inactivation of the dominant gene, Yg_2. High-temperature treatment, before irradiation, reduces the number of somatic mutations. The temperature effect remains unchanged if irradiation occurs 24 h after the heat treatment. When applied immediately after irradiation, the heat treatment has no effect (in conditions where no storage effect occurs). There is no interaction between the influence of the heat treatment and the water content of the seeds between 2 and 15%. (auth)

22261 COMPARISON OF MUTAGENIC EFFICIENCY BETWEEN ETHYL METHANESULFONATE AND IONIZING RADIATIONS IN DIPLOID WHEAT (PRELIMINARY REPORT). Fujii, Taro; Matsumura, Seiji (National Inst. of Genetics, Misima, Japan). Seiken Jiho, 18: 23-31(Dec. 1966).

Heterozygotic seeds between a chlorina mutant and a normal strain of diploid wheat were treated by γ irradiation to study chlorophyll-deficient stripes and streaks that have appeared in diploid wheat following treatment of seeds with ethyl methanesulfonate (EMS). It is not clear whether such stripes or streaks are caused by dominant mutation or are the effects of cytoplasmic abnormalities. Diploid wheat, Triticum monococcum flavescens and heterozygotic F_1 seeds from a cross between normal and chlorina were irradiated with 0.5, 1.0, and 1.5 KR of γ rays at 1 KR/hr intensity. Treatments with EMS and γ rays were combined to examine the synergistic effect of both treatments. Dry seeds of a normal strain were subjected to γ rays at 5 to 15 KR/hr intensity and 14-MeV neutrons. Neutron irradiations from a T(d,n) reaction neutron generator were applied at 300 to 900 R. After EMS and γ-ray treatments, chlorina-like stripes were observed in the F_1. In the normal strain, chlorina-like stripes were observed only in EMS-treated lots. No chlorina-like segregants were observed in the X_2 generation from seeds set on striped tillers of the normal strain showing that the chlorina-like stripes in the treated generation were caused by somatic variegation. In the F_1, frequency of tillers with chlorina stripes increased with γ-ray dose. The frequency rate in the 1.5-KR lot was similar to that of 5-KR irradiation of dry seeds. Somatic mutation frequency was ~3 times as high in wet as in dry seeds. A synergistic effect was observed in an F_1 lot treated with 0.3% EMS and 1.0 KR γ rays. The stripe frequency was much higher than that of a sum of single 1.0-KR γ-ray and 0.3% EMS treatments. Chlorophyll mutation frequency in the X_2 generation of the normal strain was higher in the single 0.3% EMS lot than in the combined lot. Mutability in presoaked seeds for 24 hr was ~10 times higher than in dry seeds. The curve of chlorophyll mutation rates in 0.5 to 1.5 KR treatments for wet seeds was almost the same as that of 5 to 15 KR treated dry seeds. The mutation curve obtained from the 0.3 to 0.9 Krad of neutron irradiation exceeded that of γ-ray lots treated with doses 10 times as large. The relative biological equivalent value of 14-MeV neutrons was 15 to 20 compared to that of γ rays. (BBB)

22262 MUTAGENESIS IN ESCHERICHIA COLI. II. EVIDENCE FOR A COMMON PATHWAY FOR MUTAGENESIS BY ULTRAVIOLET LIGHT, IONIZING RADIATION, AND THYMINE DEPRIVATION. Bridges, B. A.; Law, J.; Munson, R. J. (Medical Research Council, Harwell, Eng.). Mol. Gen. Genet., 103: 266-73(Dec. 31, 1968).

Both thymine starvation and gamma radiation, like ultraviolet light, produce base change mutations to prototrophy in Escherichia coli and the Exr^+ phenotype is involved in the mutagenic process. DNA strand breakage is a direct or indirect consequence of all three treatments suggesting that the filling of gaps in DNA by a process involving the exr gene product may be a common step in mutagenesis. (auth)

22263 MUTANT OF BACILLUS SUBTILIS SYNTHESIZING CONSIDERABLE QUANTITIES OF RIBOFLAVIN. Bresler, S. E.; Kalinin, V. L.; Kriviskii, A. S.; Perumov, D. A.; Chernik, T. P. (Inst. of High-Molecular Compounds, Leningrad. Inst. of Molecular Biology, Moscow). Genetika, 5: No. 2, 133-8(Feb. 1969). (In Russian).

After uv irradiation of the cells of the strain SHgw, a prototrophic strain of Bacillus subtilis, a mutant that synthesizes excessive quantities of riboflavin (vitamin B_2) and releases it into the culture medium was detected and isolated. This mutant was called RF1. Under certain conditions the yield of riboflavin attained 108 γ/ml. The excessive riboflavin synthesis is the only characteristic (so far known) distinguishing the mutant RF1 from the initial prototrophic strain SHgw. Besides its possible practical significance, the mutant RF1 is interesting as a model for the investigation of biochemical and genetical mechanisms of the excessive synthesis of a metabolite. (auth)

22264 INDUCTION OF MUTATIONS IN THE LAC$^-$-OPERONE OF ESCHERICHIA COLI K-12 CHROMOSOME BY γ IRRADIATION. Fradkin, G. E.; Torosyan, M. V.; Rabinkova, E. V.; Fil'kova, E. V. (Inst. of Biophysics, Moscow). Genetika, 5: No. 2, 125-32(Feb. 1969). (In Russian).

The induction of Lac$^-$ and constitutive mutations in the Lac$^-$-operone of Escherichia coli K-12 chromosome by γ radiation was studied. The following conclusions were drawn from the experimental results obtained: γ radiation of E. coli K-12 populations has a distinct effect of induction of Lac$^-$-mutations. The Lac$^-$-mutation frequency increases with increasing irradiation dose. Most Lac$^-$-mutations induced by γ radiation are point gene mutations; about $\frac{1}{3}$ of mutations are deletions. The yield of mutations with the constitutive character of β-galactosidase synthesis of the intact (spontaneous background) and γ-irradiated E. coli K-12 H cell populations is extremely low. Consequently the constitutive mutants are detected only by means of selective methods. (auth)

22265 CYTOGENETIC EFFECT OF N-NITROSOETHYLUREA, HYDROXYLAMINE, AND X-RAYS ON THE GERM-CELLS OF MALE MICE. Ramaiya, L. K. (Inst. of General Genetics, Moscow). Genetika, 5: No. 2, 74-86(Feb. 1969). (In Russian).

The cytogenetic effects of N-nitrosoethyl-urea (NEU) and hydroxylamine (HA) on spermatogonia and on various stages of primary spermatocytes (resting, mid-pachytene and diplotene stages) were compared to the effect of x rays. Saline solutions of the compounds (NEU and HA) were administered to male mice intraperitoneally. The doses used were 50 and 100 mg/kg. Irradiation doses were 100, 200, 400, and 600 R. The frequency of chromosomal aberrations was determined cytologically in the diakinesis-metaphase I using the air drying technique. The cytogenetic efficiency of both types of mutagens (chemicals and x rays) was estimated from the frequency of symmetrical and asymmetrical translocations, fragments and non-pairing chromosomes (univalents). It was found that the mutagenic effect on spermatocytes of NEU at 50 and 100 mg/kg doses was approximately equal to that of x rays at doses of 100 and 200 R, respectively. The effect of HA at a 100 mg/kg dose was similar to that of x rays at a dose of 100 R. X rays produced more fragments and univalents in spermatocytes, than NEU and HA. At all the developmental stages of spermatocytes and in all the variants of the treatment the immense majority of the translocations induced by the mutagens were asymmetrical. The mutagenic effect of HA at both doses and that of x rays at all the doses used was observed to be more conspicuous in the resting phase as compared to the other stages. The mutagenic effect of NEU at a 100 mg/kg dose was observed to be the same at all stages of development of spermatocytes. In general, spermatocytes were found to be more sensitive to the action of the mutagens studied than spermatogonia. (auth)

22266 CHROMOSOME ABERRATIONS INDUCED BY X RAYS IN THE HEMOCYTOPOIETIC MARROW OF WISTAR RATS: ELIMINATION, WITH TIME, OF THESE ABERRATIONS. Cirnu, Liliana (Inst. of Oncology, Bucharest). Arch. Anat. Microscop. Morphol. Exp., 57: 1-10(Jan.-Mar. 1968). (In French).

Cytologic studies were made of femoral bone marrow cells of rats which had been exposed to single whole-body doses of 500 R of 180 kV x rays. Chromosomes were examined two, five, and 10 days after irradiation. Results showed that there were differences in the number of abnormalities and their type encountered on each examination. There was a diminution with time in the number of abnormal cells. This seemed to indicate the existence of a process of elimination of the abnormalities. It was noted that the interval during which the number of abnormal cells diminished was approximately equal to the time necessary to replace the marrow cells. This suggests that cell division is the factor responsible for elimination of the abnormal cells seen on first examination. The mechanism likely to be responsible for these abnormalities is discussed. (BBB)

22267 IMPORTANCE OF MICROMUTATIONS IN BREEDING. II. VARIABILITY IN GRAIN YIELD, GRAIN SIZE, AND LENGTH OF GROWING PERIOD INDUCED BY X RAYS IN THE BARLEYS VOLLA AND WISA. Gaul, H.; Ulonska, E. (Max-Planck-Institut fuer Zuechtungsforschung, Cologne-Vogelsang, Ger.). Z. Pflanzenzuecht., 58: 343-68(1967). (In German).

Seed samples of Volla barley x irradiated with a dose of 17,000 R yielded 23% survival of M1 plants and 1.9% of M_2 chlorophyll mutants. Wisa barley treated with a dose of 15,000 R yielded 20% survival of M1 plants and 1.7% of M_2 chlorophyll mutants. Differences in grain yield, grain size, and date of ear emergence were measured in progeny of the M_2 to M_5 plants. Grain yields and sizes were decreased, but growing periods increased. The results were explained by natural selection on the mutants with reduced vitality. Extensive statistical analysis showed reasonable agreement between the experimental values of the selection experiments and the estimate of the expected genetic advance under selection. The effect of the positive selection for yield on the rise in the mean yields was greater than in parallel experiments with self improvement without selection. For example, in the Volla strain the mean yield values increased ~1% after the second selection step. (BBB)

22268 MULTICELLULAR CHLORELLA MUTANTS. Schwarze, P. (Max-Planck-Institut fuer Zuechtungsforschung, Cologne-Vogelsang, Ger.). Flora (Jena), Abt. A, 158: 545-8(1967). (In German).

Characteristics of mutants observed after uv irradiation of the wild forms of Chlorella vulgaris were studied. The cells were clumped into aggregates that could not be dispersed easily by mechanical agitation. It was not possible to detect structural differences between the mutants and the wild form by means of methylene blue solution. In the mutants, most of the cells of the sporangia remained bound to each other and to the germinal membrane after it was broken open. There was no apparent mechanism for splitting off of cells formed during division, after the separating membrane had been formed. After repeated uv irradiation many multicellular pigmented mutants were found, some bright green, yellow, or brown. The green mutants were capable of autotrophic growth, but also could be cultivated in darkness and light or on media that contained sugar or peptone. Under all conditions studied they produced few cells. Growth may have been hindered because of the relatively limited amount of cell surface exposed to the growth medium by the aggregated cells. The cells did not adhere to glass surfaces as much as other types of mutants that have been reported. (BBB)

22269 MUTATIONS AFFECTING ANTHOCYANIN SYNTHESIS IN THE TOMATO. I. GENETICS, HISTOLOGY, AND BIOCHEMISTRY. von Wettstein-Knowles, Penny (Univ. of Copenhagen). Hereditas, 60: 317-46(1968).

Anthocyanin formation in the tomato was studied in the following x-radioinduced mutants: ae, af, aw^2 (anthocyanin absent), ai (anthocyanin reduced), ag^3, and ag^4 (anthocyanin increased) and in other spontaneous mutants. Deviations from the anthocyanin distribution in the wild type distinguished mutant alleles at the 12 loci studied and provided the basis for classifying them into four categories: The genes ag, al, and Pn comprise the group influencing anthocyanin distribution. Three of the four known ag alleles prevent pigment formation in the stem while the fourth prohibits anthocyanin synthesis altogether. In al anthocyanin is absent in the leaves, while Pn has pigment in the basal and stalk hair cells. The five anthocyaninless mutations—af, ah, aw, bls, and ae—are classified as genes that control the intermediate stages of anthocyanin synthesis, because they can synthesize flavones and/or flavonols but not anthocyanins. The mutants a and ai differ from each other and from the normal type in the molecular structure of their principal anthocyanin. The aglycone component of the anthocyanin in a is peonidin, while the anthocyanin in ai is a petunidin based pigment whose chromatographic behavior is unlike that of any known petunidin derivative. (BBB)

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Refer also to abstracts 21655, 21824, 21838, 21936, 21937, 21940, 21942, 22037, 22052, 22098, 22104, 22150, 22180, 22331, 22400, 22401, 22419, 23236, 23239, and 23994.

22270 (AEC-tr-6944, pp 548-80) ON THE EXPERIMENTAL SUBSTANTIATION OF THE MAXIMUM PERMISSIBLE CONTENT OF ^{239}Pu IN THE HUMAN ORGANISM AND IN THE AIR OF WORK PREMISES. Lyubchanskii, E. R.; Buldakov, L. A. Translated from pp 435-61 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The literature data presented and the calculations of maximum permissible level (MPL) norms of ^{239}Pu in the human organism performed on the basis of these data show that the osteosarcomogenic effect is the most sensitive test of the toxicity of plutonium; the MPL norm derived from this criterion is 0.055 μCi. This norm is 8 to 10 times as low as the MPL derived from the lifespan criterion and 1.4 times as high as the MPL adopted in the Soviet 1960 standards (0.04 μCi). The maximum permissible concentration (MPL) of ^{239}Pu in the air of work premises, derived from the available data on the patterns of metabolism of this isotope in the organism of the rat on inhalation, amounts to 3.6 × 10^{-15} Ci/l and is 1.8 times as high as the MPC adopted in the Soviet 1960 standards (2 × 10^{-15} Ci/l. When the ^{239}Pu concentration in the inhaled air does not exceed the calculated MPC norm, the actual content of ^{239}Pu in the human organism toward the end of active work-life (at the age of 70) is three times as low as calculated in theory (0.055 μCi); this is assured by the existing labor legislation. For the currently effective MPL of ^{239}Pu (0.04 μCi), the safety factor with respect to the human individuals most sensitive to the effect of ionizing radiation is 1.4. For the currently effective MPC of ^{239}Pu in the air of work premises (2 × 10^{-15} Ci/l) the overall safety factor is 5.4 (1.8 × 3). As new information on the biological effect and metabolism of ^{239}Pu is acquired, the MPL and MPC norms should be periodically carefully revised. (tr-auth)

22271 (AEC-tr-6944, pp 592-8) USING Na_3Ca DTPA (PENTACIN) TO ELIMINATE ^{239}Pu FROM THE ORGANISM OF THE RAT WITH INHALATION POISONING. Lyubchanskii, E. R. Translated from pp 471-6 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The prevention of the build-up of ^{239}Pu in the body after administration via the respiratory tract by the inhalation of cis(carboxymethylimine) bis(ethylenenitrilo) tetraacetic acid (DTPA) was studied. An attempt was also made to determine the site of interaction between DTPA and ^{239}Pu. Rats were exposed to a single 20 min inhalation of a ^{239}Pu citrate solution (pH = 6.5, 30 μCi/ml). Single-dose prophylactic inhalation of DTPA (1.8 mg) prevented, to a large degree, the deposition of the plutonium in the rat's body. As the interval of time between the inhalation of plutonium and of DTPA increased, the effectiveness of the latter diminished. Administration of small amounts of DTPA (1.8 and 3.6 mg) 40 days following the inhalation of plutonium did not affect the content of this isotope in the rat organs. By contrast with inhalation, prophylactic intravenous administration of DTPA (2.5 mg) did not reduce the activity in the lungs and skeleton following the penetration of ^{239}Pu via the respiratory pathways. (M.M.B.)

22272 (AEC-tr-6944, pp 599-606) USING CERTAIN TETRACYCLINES TO ELIMINATE RADIOACTIVE STRONTIUM FROM THE ORGANISM. Razumovskii, N. O.; Torchinskaya, O. L.; Smolin, D. D.; Balabukha, V. S.; Tikhonova, L. I.; Razbitnaya, L. M. Translated from pp 476-82 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effectiveness of the compounds of the tetracycline series as means of preventing the deposition of ^{89}Sr in bones was investigated. Strontium-89 was administered in the form of a chloride without carrier to rats in a single dose of 0.1 μCi/g. The tetracyclines were administered in equimolar amounts in the form of aqueous solutions of 100 μmoles per animal in a single dose simultaneously with ^{89}Sr or 30 minutes prior to the administration of ^{89}Sr or perorally in amounts of 100 μmoles per animal once daily for five days with the first injection being administered 24 hours following the intraperitoneal injection of the radioactive isotope. Chelating properties of the tetracycline-base, N-morpholinemethyltetracycline (KC-30) and N-diethanolaminemethyltetracycline (KC-32) were determined by spectrophotometric and chromatographic methods. The build-up of radioactive strontium in the bones increased somewhat when this isotope was administered immediately before, or 30 minutes after, the intraperitoneal administration of the tetracyclines. Peroral administration of the tetracyclines prophylactically (30 minutes before) or immediately after the entry of radioactive strontium into the gastrointestinal tract reduced the skeletal build-up of this isotope by 30 to 40%. Daily administration of the tetracyclines, commenced 24 hours following the incorporation of radioactive strontium, had little effect on the skeletal content. (M.M.B.)

22273 (AEC-tr-6944, pp 607-14) PREVENTING THE PENETRATION OF RADIOACTIVE STRONTIUM FROM THE GASTROINTESTINAL TRACT INTO THE SKELETON BY MEANS OF ION EXCHANGE RESINS (CATION EXCHANGERS). Razumovskii, N. O.; Torchinskaya, O. L. Translated from pp 607-14 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Sulfo-, carboxy- and phosphate-cation exchangers were tested on rats with the object of reducing the amount of radioactive strontium penetrating from the gastrointestinal tract into the skeleton. The lowest build-up of radioactive strontium in the femoral bones was observed when administering the cation exchangers KU-2, RF, SBS and Dowex-50. The sodium form of most of the investigated cation exchangers proved to be more effective than their ammonium and hydrogen forms. Fine-disperse cation exchangers produced better results than their macrograined specimens. (tr-auth)

22274 (AEC-tr-6944, pp 622-5) ELIMINATION OF RADIOACTIVE STRONTIUM AND POLONIUM FROM THE BLOOD BY MEANS OF ION EXCHANGERS. Krylov, K. P. Translated from pp 494-6 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Studies were made to identify the ion exchangers most suitable for eliminating certain radioactive elements from the blood. Fourteen Soviet-produced ion exchangers were tested with respect to ^{90}Sr and ^{210}Po: the cation exchangers SF, SF-1, SBS-2g, SBS-3g, SDV-3, KU-2, RF, PPS-3, PPF-1; and the anion exchangers ASD-4, ASD-5, AN-9, MMG-1, EDE-10. One half g of the ion exchanger (cation exchangers in sodium form, anion exchangers in OH form), 0.5 mm grain size, was placed in polyethylene or glass columns measuring 9 mm in diameter and 15 cm in height, with a caprone filter at the base as well as with soft polyethylene end covers. Thirty min prior to the beginning of the experiment the ion exchangers were wetted with saline solution. The rate of blood flow was regulated with the aid of screw clamps. A catheter was inserted in the femoral vein of dogs under local anesthesia: the radioactive isotope was injected subcutaneously (0.1 μCi/kg). One or two hours after the injection of ^{90}Sr and three hours after the injection of ^{210}Po blood was collected via the catheter and passed in 10 cc portions through each column within 10 sec to 5 min. The radioactivity of the original blood and of the blood treated with ion exchangers was analyzed by the methods conventionally employed for these isotopes. The number of formed elements in the blood before and after its passage through a column was counted. In experiments with ^{210}Po, following the collection of blood, the dogs were intravenously injected with 50 mg/kg of a chelating agent (dithiol), and 15 min later their blood was again collected and treated with the ion exchangers. Treatment did not appreciably affect the counts and mutual ratios of formed elements of the blood. The method made possible the elimination of as much as 98.5% of the initial ^{90}Sr activity after a single passage of the blood through the ion exchanger. Some of the investigated cation exchangers (RF, PPS-3) warrant further investigation, particularly in experiments in vivo. The elimination of ^{210}Po with the ion exchangers tested was relatively ineffective (about 13% of the original activity). Prior administration of dithiol did not increase the low degree of recovery of ^{210}Po by either anion exchangers or cation exchangers. (M.M.B.)

22275 (AEC-tr-6944, pp 670-7) ANTIDOTE THERAPY OF URANIUM AND POLONIUM POISONING. Borisov, V. P.; Ivannikov, A. T.; Mikhailovich, S. M. Translated from pp 531-7 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

An investigation was made of means of preventing resorption of soluble compounds of uranium and polonium from the intestines of rats. Polonium-210 and ^{238}U were administered in the form of soluble compounds of uranyl nitrate and polonium nitrate in bismuth. The uranyl nitrate was administered in a single intragastric dose (100 mg/kg of 0.5% aqueous solution) and the polonium, in the Ci form of aqueous solution in mannite (0.2 μCi/kg) also intragastrically. The antidotes were administered in tolerable single or multiple doses daily for five days starting immediately or one hour after poisoning, with the aid of an olive-equipped intragastric probe. The control animals received intragastric doses of 2 cc of saline solutions each. The doses of the antidotes were as follows: antidote against heavy metals, 1 ml of diluted (1:5) antidotum metallorum per animal; hydroquinone sulfohydrate (0.5 percent solution), 2 ml per animal (10 mg); bismuth nitrate, 4 percent aqueous suspension, 80 mg per animal; activated charcoal (carbolen), 4 percent aqueous suspension, 2 ml per animal in experiments with polonium; 10 percent suspension — 4 ml per animal in experiments with uranium; tannin 4 ml of 10 percent solution (pH = about 3) per rat; universal 10 percent adsorbent (activated charcoal, tannin, magnesium oxide), 4 ml per rat; sodium phosphates, 3 ml of 10 percent solution per rat at the rate of 30 mg per animal (monosubstituted sodium phosphate with pH = 5; disubstituted, with pH = 8, and their neutral mixture with pH = 7). The most effective means of reducing uranium absorption from the intestine was disubstituted sodium phosphate (or its neutral mixture with monosubstituted sodium phosphate). On poisoning with ^{210}Po, an effective antidote was the official antidote against heavy metals, the alkali solution of hydrogen sulfide (antidotum metallorum), as well as hydroquinone sulfohydrate. Activated charcoal, universal adsorbent and bismuth nitrate were ineffective. (M.M.B.)

22276 (AEC-tr-6944, pp 678-87) EFFECT OF 2-ACETYLAMINO-1,3,4-THIADIAZOLE-5-SULFONAMIDE ON THE ELIMINATION OF URANIUM FROM THE ORGANISM AND ON THE COURSE OF ACUTE URANIUM POISONING. Ivannikov, A. T. Translated from pp 537-45 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The rapidly developing poisoning of the kidneys is decisive in acute uranium poisoning. A preparation selectively influencing the reabsorption of bicarbonates from the renal canaliculi was employed to accelerate the elimination of uranium from rats. It was a diuretic preparation, 2-acetylamino-1,3,4-thiadiazole-5-sulfonamide (diacarb). The effect of 100 mg/kg of diacarb on the elimination of uranium from the organism during acute uranium poisoning was investigated. Uranyl nitrate was injected subcutaneously in the form of a 0.25 percent aqueous solution in a dose of 5-30 mg/kg. It was found that uranium elimination can be accelerated and injury to the organism prevented, with diacarb, a chemical acting as carboanhydrase inhibitor. Diacarb was effective in the early stages of acute uranium poisoning. The protective effect decreased with increase in the dose of uranyl nitrate and in the time elapsed since the administration of that dose. Treatment in late stages of uranium poisoning aggravated the course of the poisoning. The effectiveness of diacarb was magnified by administering it in a combination with sodium bicarbonate, with respect to both accelerating the elimination of uranium and increasing the survival time of the experimental animals. The most distinct protective effect was produced by prophylactic (1 to 3 hours prior to poisoning) administration in combination with sodium bicarbonate. In this case a single-dose administration of diacarb together with sodium bicarbonate prevented the development of severe uranium poisoning and death of the animals following the injection of a uranyl nitrate in a dose normally causing 100% mortality of rats. (M.M.B.)

22277 (AEC-tr-6944, pp 703-9) EFFECT OF THERAPEUTIC INTERVENTION ON THE LONG-TERM CONSEQUENCES OF POISONING WITH THE FISSION PRODUCTS OF URANIUM. Mikhailovich, S. M.; Krotova, S. I.; Erleksova, E. V. Translated from pp 558-63 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The fission products of uranium, when administered internally in the dose of 8 μCi per kg body weight, caused acute radiation sickness in the dog and reduced its lifespan to 11 to 19 days. Single gastric lavage one hour following the administration of the fission products of uranium in the above dose converts the acute form of radiation sickness to chronic. Then the lifespan of the animals is prolonged to from 1.5 years to 12 years. The clinical picture of the radiation poisoning during the period from the 1st to the 8th year revealed fluctuations of the investigated indicators within the limits of the original levels against a background of constant minor leukopenia. Following the 8th year the animal began to display erythropenia, thrombopenia and occasional neutrophilic leukocytosis. Ophthalmological examination of the dog revealed an accelerated onset of senescence in the form of a marked decrease in the pigment of the retina and iris and pupillary limbus along with progressive cataract and sclerosis of the retinal vessels. This was accompanied by a rise in intracranial pressure (enlargement of optic-nerve disk, its pallidness, edema and bulging into the corpus vitreum). Prolonged internal effect of the residual fission products of uranium following gastric lavage administered one hour after radiation poisoning has, as confirmed by autoradiograms, after 12 years resulted in the development of a malignant skeletal tumor metastically spreading into the lungs, along with degenerative changes in the internal organs and the development of adenomas in the endocrine glands. (tr-auth)

22278 (AEC-tr-6944, pp 713-18) EFFECT OF CERTAIN COMPLEX-FORMING AGENTS ON THE BUILD-UP LEVEL OF THE RADIOACTIVE ISOTOPES OF ZIRCONIUM, NIOBIUM, AND RUTHENIUM IN THE ORGANISM OF THE RAT. Razumovskii, N. O.; Torchinskaya, O. L.; Yashunskii, V. G. Translated from pp 566-71 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Chelating agents were tested for their effectiveness in removing ^{95}Nb, ^{106}Ru, and ^{95}Zr from rats. The isotopes and chelating agents were administered in single intraperitoneal doses to the animals. Radioactive isotopes without carriers were administered to all the rats in the amount of 0.1 μCi per g body weight. The isotopes ^{95}Zr–^{95}Nb and ^{95}Nb were injected in the form of solutions of oxalate salts having the acidity 0.1–0.7 $\underline{N}$ $H_2C_2O_4$, and the isotopes ^{106}Ru–^{106}Rh, in the form of chloride (acidity 1 to 3 $\underline{N}$ HCl). Diethylenetriaminepentaacetic acid (DTPA), 2-oxypropane-1,3-diaminetetraacetic acid (PDTA), and N,N,N′,N′-tetraacetic acid of 2,2′-diaminodiethyl sulfide (DESTA) were administered in the form of calcium-sodium salts, 200 μmoles per animal, simultaneously with the radioisotope or prior to the latter (prophylactically) or following the incorporation of the latter. The tested compounds may be arranged in decreasing effectiveness in eliminating ^{95}Zr and ^{95}Nb from the rats: PDTA > DTPA > LESTA; the degree of effectiveness of these agents in eliminating ^{106}Ru was: PDTA > DESTA > DTPA. (M.M.B.)

22279 (AEC-tr-7019) INTERNAL BODY DOSIMETRY AFTER ^{90}Sr–^{90}Y INCORPORATION IN RATS. Steinbach, K. H.; Kriegel, H. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from Atompraxis, 14: 336-8(1968). 5p. Dep. CFSTI.

The performance of implanted thermoluminescent detectors for measurements of the radiation dose from internally-deposited radioisotopes was evaluated. Results are reported from measurements of the β radiation dose to the liver of rats as a function of incorporation time of intravenously administered ^{90}Sr and ^{90}Y in equilibrium. Good agreement was found between the calculated and measured radiation dose. (C.H.)

22280 (BNWL-SA-2282) SIMULATED MODEL FOR DETERMINING THE DISTRIBUTION OF ALPHA-ENERGY IN ALVEOLI FROM INHALED PLUTONIUM PARTICLES. Dionne, P. J.; Sanders, C. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 21, 1969. Contract AT(45-1)-1830. 12p. (CONF-690106-2). Dep. CFSTI.

From Northwest Simulation Council Meeting, Portland, Ore.

The maximal permissible concentrations allowed currently for radioactive particles in the atmosphere have been calculated on the basis of a uniform distribution of the isotope and radiation dose in the lung utilizing a general lung model, adopted and refined by the International Committee on Radiological Protection, for the fate of inhaled radioactive particles. Alpha irradiation from $^{239}PuO_2$ particles has a very limited penetration in tissue. For this reason and because the plutonium is concentrated within particles, the distribution of radiation dose in the lung from inhaled plutonium particles is confined to 100μ spheres of tissue surrounding each particle. Several recent studies have demonstrated that certain biological mechanisms result in further radiation dose concentration. Most of inhaled $^{239}PuO_2$ particles deposited in the alveoli of rats were rapidly phagocytized by pulmonary macrophages. Particle localization and identification in macrophages was accomplished by light and electron microscopic autoradiography. Using a technique of alpha-track counting on autoradiograms to relate the phagocytized mass of plutonium, it was shown that particles deposited in alveoli are not only phagocytized but concentrated within pulmonary macrophages. The net result of particle phagocytosis and concentration within macrophages is the further increased concentration of alpha-dose in alveoli with the macrophage absorbing the greatest dose. A hybrid computer alveolar model was developed in order to demonstrate the distribution of alpha energy in the alveoli and the modifying influence of pulmonary macrophages on the alveolar alpha-energy from phagocytized particles. (auth)

22281 (CEA-R-3681) ^{90}Sr CONTENT OF HUMAN BONE COLLECTED IN 1967. Jeanmaire, Lucien; Patti, Francois (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). Jan. 1969. 9p. (In French). Dep.

Tables of the strontium-90 content of human bones collected in 1967 in the Paris area are presented. The main trend is much the same as during 1966; contamination levels are falling down in infants up to 5 years old. Beyond this age, the values are the same or experience a slight increase. (auth)

22282 (EUR-4198) STUDY OF PSYCHOLOGICAL ATTITUDES OF NUCLEAR WORKERS TOWARDS RADIOACTIVITY RISK. Final Report. Sivadon, P.; Fernandez, A. (Centre de Recherches Psychopathologiques, Paris (France)). Dec. 1968. Contract 002-62-10-PSTF. 154p. (In French). Dep.

In reference to the potential variety of the psychological attitudes found among nuclear workers toward radioactivity risk, the report lays stress on their origins and the motivations that change them—knowledge acquired, individual integration of safety measures, and influence of surroundings. Several methods of approach are called for in a study of such attitudes: analysis of personal histories and medico-psychological clinical examination; analysis of responses to certain psychometric tests and personality projection tests; objective analysis of psychological aspects connected with the job; collective approach and study of the dynamics of the working parties and circles in which the worker moves. The final psychological attitudes are complex and have a shifting history. Knowledge of them will be of the utmost value in improving adaptation to radioactive hazard and obtaining the right responses to the ups and downs of individual and collective safety conditions. (auth)

22283 (HASL-204(App.)) FALLOUT PROGRAM. Quarterly Summary Report, September 1–December 1, 1968. Appendix. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jan. 1, 1969. 364p. Dep. CFSTI.

Data are tabulated on the content of fallout ^{89}Sr and ^{90}Sr in samples of precipitation collected at 36 sites in the U.S.A., at 103 sites in other countries, and at Atlantic Ocean weather stations during 1968. The gross γ radioactivity and content of ^{54}Mn, ^{55}Fe, ^{89}Sr, ^{90}Sr, ^{95}Zr, ^{109}Cd, ^{137}Cs, ^{140}Ba, ^{141}Ce, ^{144}Ce, ^{238}Pu, and ^{239}Pu in samples of surface air collected at various U.S.A. and world sites are reported and compared to samples collected since 1963. (C.H.)

22284 (NP-17782) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 6, Number 9. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Sept. 1968. 21p. Dep.

Canadian fallout data for August, 1968, are presented including beta activities of the atmosphere and in precipitation, and cesium-137, strontium-89 and strontium-90 content in whole milk. Reactor environmental data include cesium-137, strontium-89, and strontium-90 content in Lake Huron, the Ottawa River, and the Winnipeg River. Also, a selected list of divisional reports and bulletins is presented. (W.H.K.)

22285 (NP-17807) FOURTH ACTIVITY REPORT OF THE RADIOACTIVE FALLOUT LABORATORY, AUGUST 1966–JULY 1967. (Atomic Energy Commission, Ankara (Turkey)). 1969. 16p. (In Turkish). Dep.

Results of fallout measurements in the atmosphere, milk, rain, and snow are reported for the period of August 1966, to July 1967. Samples were taken in the Ankara area of Turkey. Daily gross β activity of atmospheric sampling are presented in tabular form. With the exception of some high values that correspond to the date of nuclear explosions in France, the activity continuously decreased. In 1967, the ^{90}Sr content of milk was generally low (about 7 pCi/l. Strontium-90 content of rain and snow were generally low, and some of the high activity values that were observed were considered to be due to previous French tests. (C.O.)

22286 (NP-17823) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 6, Number 10. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Oct. 1968. 21p. Dep.

Data collected during September 1968, on fallout content of the atmosphere, atmospheric precipitation, and milk in Canada are presented in tabular form. The average fallout values for September 1968, showed little change from those of previous months. The average content of ^{137}Cs and ^{90}Sr in liquid milk were 31 pCi/l and 11.5 pCi/l respectively. Also presented are data on total α and β activity determinations of water samples obtained from the Ottawa River and Lake Huron; these same samples were analyzed for ^{89}Sr, ^{90}Sr, and ^{137}Cs. Data were in general agreement with observations made in the fallout program and did not show any anomalies that could be attributed to a release of contamination from reactors. A selected list of reports and bulletins is appended to the report. (C.O.)

22287 (NYO-3086-8, pp I.1-42) IONIZING RADIATION DOSE RECEIVED BY RODENTS LIVING ON THE MORRO DO FERRO, BRAZIL. Drew, Robert T.; Eisenbud, Merril (New York Univ., N. Y. Inst. of Environmental Medicine).

Field and laboratory experiments were performed on rats to determine whole-body dose from external radiation, dose to bone from internally deposited radioisotopes, dose to lung tissue from inhalation of radon, thoron, and their daughters, and dose to other organs from ingested or inhaled short-lived daughters of thoron. Tables are presented to show dose estimates of ^{212}Bi, ^{212}Pb, ^{214}Pb, ^{214}Po, ^{218}Po, ^{226}Ra, and ^{228}Th to tissues of rats. It was concluded that rodents living on the Morro do Ferro are receiving high annual doses to the trachea, bronchi, and alveolar tissue from inhalation of thoron and daughters. The dose to the trachea and bronchi, directly related to the thoron and daughter concentrations, ranges from about 30 to 1200 rads/yr. (H.L.W.)

22288 (NYO-3086-8, pp VII.1-29) INVESTIGATION OF THE REDUCTION OF RADON DAUGHTER CONCENTRATIONS IN URANIUM MINES BY RAPID MIXING WITHOUT MAKEUP AIR. Wrenn, M. E.; Eisenbud, Merril; Hazle, A. J.; Siek, R. D.; Ribeiro, C. Costa (New York Univ., N. Y. Inst. of Environmental Medicine).

A brief review of the properties of radon and its daughters is given, and a non-vented air circulation system using high-voltage electrostatic collection is described for reducing radon daughter concentrations in uranium mines. Experimental data are presented. (W.H.K.)

22289 (NYO-3086-8, pp IX.1-19) AUGER ELECTRON DOSIMETRY. Wrenn, McDonald E.; Howells, Gwynne Parry; Hairr, Leland M. (New York Univ., N. Y. Inst. of Environmental Medicine).

The process of electron capture and the subsequent deexcitation of the daughter nuclide involving both x-ray and Auger electron emission is discussed; and a brief description of Auger electron dosimetry of internally deposited radioisotopes is given. Also, some electron capture nuclides of specific biological interest are tabulated. (W.H.K.)

22290 (NYO-3086-8, pp XI.1-13) ANALYSIS OF ^{210}Pb IN THE URINE OF URANIUM MINERS. Cohen, Norman; Kneip, Theo. J. (New York Univ., N. Y. Inst. of Environmental Medicine).

A method was developed for simple and accurate determination of ^{210}Pb in the urine. After a 30 day waiting period to allow ^{210}Pb–^{210}Bi equilibrium, ^{210}Bi is plated directly out of 500 ml of urine onto a stainless steel planchet. The sample is then beta counted under a 6.85 mg/cm aluminum foil in a low background proportional counter. Polonium-210 may also be determined for the same sample by alpha counting the planchet. Preliminary results correlating ^{210}Pb in the urine of uranium miners with their cumulative exposure history indicated a significant relationship for individuals no longer engaged in mining operations. (auth)

22291 DOSIMETRY IN THE CASE OF SEALED SMALL SOURCE FOR CANCER THERAPY. A RENTAL CALCULATION METHOD BY COMPUTER. Yasukochi, Hiroshi; Ihno, Yu (Tokyo Univ.). Nippon Igaku Hoshasen Gakki Zasshi, 28: 1296-1306 (Dec. 1968). (In Japanese).

Because of the remarkable progress of high energy medical radiation apparatuses, teletherapy using betatron, linac and telecobalt is now the procedure for almost all cancer therapy in the field of radiation treatment. However, inserting sealed small source therapy applied interstitially and/or intracavitary shows better results in some kinds of tumors such as those of the tongue and the uterine cervix. For the technique of this inserting therapy, the dose calculations in the tumor are the most critical and most troublesome part of the procedure. A most widely accepted technique is the mean dose calculation in the tumor which is determined from calculated tables on the relationship between the total dose of the inserting sources and the volume of the tumor. Practically, it is very difficult to determine the volume of the irradiated area. The radiation dose of some selected points is also used for this purpose which is point A and B in the intracavitary radium therapy for cancer of the uterine cervix. Or the isodose curve for the area may be used by summing up the isodose curve charts of each source. The use of electronic computers has been attempted. These attempts seem to have two opposite directions. One is to apply this technique for more accurate dose calculation near the sources. This was almost impossible by manual calculations because of the complex factors concerning the calculations such as the differences of the absorption length to the directions of the sealing material and the radium itself. Another is to utilize the calculation from simple formulas or simple tables and to calculate the dose distributions for each patient at each time. In practice, the errors of the calculated radiation dose depend mainly on the fixability of the source position, during the treating periods, and on the nature of the tumor and the surrounding tissues. For these reasons, practical calculations do not need extremely accurate theoretical dose distributions in patients though more accurate dose distribution may lead to better results in therapy. The errors are discussed from the statistical viewpoint and many negligible errors are omitted. The dose distributions are calculated in every 0.5 cm square in one plane near the sources according to a simple formula. Each formula can be selected according to the capacity and the ability of the computer applied. The calculation procedures are sent to doctors. The positions of the sources from the x-ray films of two perpendicularly crossing directions are detected by them and mailed to the calculation center or the company, and the calculated results returned. By this system any hospital can receive accurate calculated radiation dose distributions, without having any knowledge of the programming of computers or any computers in the hospital. Investigations on the range of neglected errors and practical examples are presented. Following these procedures, calculation cost for each patient is about 2,000 yen for the method of three figures of three perpendicularly crossing planes around the center of the tumor. It is hoped that many doctors will use this program and procedure to lower the cost of the calculation fees. (TSS) (auth)

22292 ILLINOIS LASER SYSTEM REGISTRATION LAW. Courtney, Russell W. (Illinois State Dept. of Health, Springfield). Arch. Environ. Health, 18: 413-15(Mar. 1969).

The provisions of the law are outlined and some early experience under it is detailed, including the discovery of abuses. Limitations of the law and possible needs for further action are discussed. (C.O.)

22293 RADIATION CONTROL FOR HEALTH AND SAFETY ACT, 1967 S-2067. Brown, Clarence J. (House of Representatives, Washington, D. C.). Arch. Environ. Health, 18: 408-12 (Mar. 1969).

The developments in knowledge and uses of radiation are reviewed. The growth in uses is compared with advances in research and with the recognition of the need for safeguards. Historical and present roles of both the state and federal governments in control of radiation are discussed, and the provisions of the Radiation Control for Health and Safety Act are evaluated in terms of present and future needs. (C.O.)

22294 LASER PROBLEMS AS RELATED TO THE NATION'S HEALTH. Powell, Charles (Univ. of Missouri, Columbia); Brown, Murray C. Arch. Environ. Health, 18: 391-3(Mar. 1969).

The techniques of industrial hygiene and epidemiology have now been combined in an effective survey procedure that permits assessment and control of potential occupational health hazards associated with laser operations. Industrial hygiene practice at the laser workplace and the health of laser workers in relation to others employed in similar standard industrial classifications can be surveyed and evaluated. A national occupational health survey of laser users is feasible; the objectives are defined. Preliminary data from several geographical areas studied are presented. (C.O.)

22295 HEALTH ASPECTS OF LASER USE. AIR CONTAMINATION AND LASERS. Wilkinson, Thomas K. (National Inst. of Health, Bethesda, Md.). Arch. Environ. Health, 18: 443-7 (Mar. 1969).

Vaporization or fragmentation of harmful viable or nonviable substances associated with laser operations or generated by the beam's impact may present a health hazard to those working with this equipment. The question that comes to mind is "Does a real problem exist?" No information is available showing that a person has suffered any injury from contact with aerosols generated by a laser. However, based on experience and animal experimental work, there appear to be sufficient grounds to warrant strict control measures where high power density laser energy is used on potentially harmful viable or nonviable material. (auth)

22296 THE EYE: PROTECTION. Swope, C. Hermas (American Optical Corp., Framingham, Mass.). Arch. Environ. Health, 18: 428-33(Mar. 1969).

The effects of lasers on the eye are reviewed. Two alternatives for providing safety for the eye are guaranteeing that the beam cannot be directed to anyone's eye or attenuating the beam before it could reach an eye. For one-Joule ruby laser, the attenuation would have to be by a factor of 10,000. Ordinary techniques, such as sunglasses, welder's goggles, and bright light to constrict the pupils are not adequate. The construction of specialized goggles and their properties in protection against various types of lasers are described. The development of laser systems that incorporate safety features is also discussed and illustrated. (C.O.)

22297 DOSIMETRY STUDIES OF A HIGH-ENERGY NEUTRON BEAM. Baarli, J.; Sullivan, A. H. (CERN, Geneva). Phys. Med. Biol., 14: 269-76(Apr. 1969).

The dose distribution in a water phantom from a high-energy neutron beam produced by the CERN 600 MeV synchrocyclotron was measured and the characteristics of the beam were investigated. A method for estimating the absorbed dose to biological specimens in a high energy neutron beam, using thermoluminescent detectors, is described. The dose to a biological specimen can be estimated to within about ±15% at small depths where the dose is varying rapidly with depth. Radioactivity induced in biological material by high-energy neutrons makes a negligible contribution to the total dose. (auth)

22298 AGRICULTURE AND THE QUALITY OF OUR ENVIRONMENT. A Symposium Presented at the 133rd Meeting of the American Association for the Advancement of Science, Washington, D. C., December 26–31, 1966. Brady, Nyle C. (ed.). AAAS Publication 85. Washington, D. C., American Association for the Advancement of Science, 1967. 472p. $13.50. (CONF-661217).

Thirty articles were presented at the symposium on agriculture and air quality (10), agriculture and water quality (10), soil pollution in agriculture (5), and human and animal wastes (5). Separate abstracts were prepared for three items concerned with radioisotope contamination of soils, plants, and animals. (C.O.)

For abstracts of individual papers see: 22299–22301.

22299 AIRBORNE RADIONUCLIDES AND ANIMALS. Bell, M. C. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-GEN-242. Amer. Ass. Advan. Sci., Symp., 133rd, 77-90(1966) (Publ. 1967).

From Symposium on Agriculture and the Quality of our Environment, Washington, D. C. See CONF-661217.

Selected data on radiotoxicity of airborne radioisotopes for food-producing animals are presented. Emergency food countermeasures useful in reducing the radiation exposure of livestock and man are briefly discussed. Consideration is given information on farm animals as food producers, sources of radioactivity, animal exposures, and countermeasures. It was concluded that damage to skin and hair has been the primary observed effect of radioactive fallout on cattle and that grazing animals have a high tolerance for the ingested radioisotopes that are poorly absorbed. Of the absorbed radioisotopes, iodine was a major hazard because of thyroid damage, but this could be overcome by feeding thyroactive compounds. Progress on feeding livestock to alter absorption of airborne radioisotopes was not promising. Processing of human food from animal sources to remove radioisotopes was more promising than altering livestock feeding practices. (C.O.)

22300 THE EXTENT AND SIGNIFICANCE OF SOIL CONTAMINATION WITH RADIONUCLIDES. Reitemeier, R. F. (Atomic Energy Commission, Washington, D. C.); Hollister, Hal; Alexander, L. T. Amer. Ass. Advan. Sci., Symp., 133rd, 269-82(1966)(Publ. 1967).

From Symposium on Agriculture and the Quality of our Environment, Washington, D. C. See CONF-661217.

The types and present content of radioisotopes in soil, soil and plant relations of those isotopes, and the significance of present radioisotope levels in soils are discussed. (C.O.)

22301 AIRBORNE RADIONUCLIDES AND PLANTS. Menzel, Ronald G. (Dept. of Agriculture, Beltsville, Md.). Amer. Ass. Advan. Sci., Symp., 133rd, 57-75(1966)(Publ. 1967).

From Symposium on Agriculture and the Quality of our Environment, Washington, D. C. See CONF-661217.

Current information on the factors governing the deposition of radioactive materials from the air and their retention by plants is reviewed and summarized. Consideration is given to the effects of background radiation on the evaluation of hazards from radioactive fallout in the environment, the nature of airborne radioisotopes, mechanisms of radioisotope deposition, mechanisms and factors affecting radioisotope retention by plants, and the effects of radioisotope contamination on the plant. (C.O.)

22302 REDUCTION OF ^{85}Sr UPTAKE IN FIELD CROPS BY DEEP PLOWING AND SODIUM CARBONATE APPLICATION. Menzel, R. C.; Eck, H. V.; James, P. E.; Wilkins, D. E. (Soils Lab., Beltsville, Md.). Agron. J., 60: 499-502(Sept.-Oct. 1968).

Deep plowing reduced uptake of ^{85}Sr by four irrigated crops on Pullman silty clay loam at Bushland, Texas. Uptake was further reduced when Na_2CO_3 was plowed under with the ^{85}Sr. The relative concentrations of ^{85}Sr in mature soybean (Glycine max), sugar beet (Beta vulgaris), sudangrass (Sorghum sudanese), and cabbage (Brassica oleracea var capitata) plants grown with ^{85}Sr applied in different treatments were: rotary tilled 20 cm deep, 100; plowed 90 cm deep, 25–50; plowed 90 cm deep with 22,400 Kg/ha (10 tons/acre) of Na_2CO_3, 3–7. In the plowing treatments, 90% of both the ^{85}Sr and the Na_2CO_3 was banded in the furrow deeper than 75 cm. Crop yields were increased by deep plowing and were affected very little by the application of Na_2CO_3. This experiment demonstrates that a toxic chemical can be plowed under deeply with radioactive contamination to reduce the uptake of the radioactive material with little effect on yield from the chemical. (BBB)

22303 DIRECT MEASURES AT THE INCIDENT SITE FROM THE MEDICAL VIEWPOINT. Moehrle, G. (Kernforschungszentrum, Karlsruhe, Ger.). pp 13-18 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Detailed plans for treatment centers at the incident site are presented. The nuclear research center at Karlsruhe serves as basis since due to its complexity it represents a variety of possibilities in nuclear incidents. Available statistics suggest that the majority of persons involved in radiation accidents do not require hospitalization. The following measures are suggested: radiation protection section staffed by qualified health physics personnel; laboratory, equipped to perform immediate elimination analysis and other tests related to radiotoxicology; two full time physicians (one internist, one surgeon) capable of treating serious accident cases with up to date equipment; immediate decontamination. The permissible radiation dose to rescue teams in accident situations is briefly discussed. (H.B.G.)

22304 ELIMINATION OF INCORPORATED RADIOACTIVE MATERIAL. Kriegel, H. (GSF Munich, Neuherberg, Ger.). pp 99-106 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Therapeutic measures following intake of radioactive substances are discussed. To avoid delayed radiation damage, an attempt must be made to eliminate radioactive material totally or partially. Research efforts should concentrate on isotopes of high biological importance. Based on animal experiments elimination of radioactive isotopes is reviewed. Radiostrontium elimination in man through administration of barium sulfate is briefly discussed. (H.B.G.)

22305 CHROMOSOME INVESTIGATIONS AFTER EXTRAORDINARY RADIATION BURDEN. Wolf, U.; Schneider, G. (Univ., Freiburg i. B.). pp 136-41 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Reviewed are radiation induced aberrations of chromosomes with emphasis on those observed in leukocyte cultures. At present, the procedure is too time-consuming to permit rapid evaluation of nuclear accidents; however, the great sensitivity of the method might make it ideal for both the assessment of minor radiation incidents and delayed consequences of exposure. (H.B.G.)

22306 HEMATOLOGICAL PATTERN MONITORING OF RADIATION INJURY. Stecher, G. (EURATOM, Freiburg i. B.). pp 114-27 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Reviewed is the diagnostic importance of hematological changes following nuclear accidents, with emphasis on early bone marrow examination. Significant radiation doses cause myotic anomalies within one or two days postexposure. These early changes occur especially in the erythropoietic components. (H.B.G.)

22307 BIOCHEMICAL STUDIES AFTER RADIATION INCIDENTS. Streffer, C. (Univ., Freiburg i. B.). pp 127-34 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Reviewed is the urinary excretion of amino acids following both experimental irradiation of animals and accidental exposure of humans. Thus far, the prognostic value of biochemical determinations is inferior to that of hematological data. (H.B.G.)

22308 PRACTICAL INDICATIONS FOR THE ELIMINATION OF INCORPORATED RADIOACTIVE MATERIAL. Catsch, A. (Univ., Karlsruhe (TH), Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 107 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Elimination of radioactive material from the body is briefly discussed. Emphasized are various chelating agents, especially with respect to removal of plutonium-239. For the mobilization of cesium-137, Berlin blue is the agent of choice. Thus far, little research has been done about the elimination of radioactive anions, e.g., tritium, phosphorus-32, and iodine-131. Dilution with stable isotopes may be the most promising approach. (H.B.G.)

22309 PHYSICAL MONITORING PROBLEMS IN RADIATION INCIDENTS. Dresel, H. (Univ., Freiburg i. B.). pp 21-6 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Monitoring of radiation incidents is discussed from the viewpoint of the radiation safety officer. Prognosis of the clinical course is largely determined by radiation dose. Therefore, capabilities for rapid and thorough diagnosis must be established. From existing safety rules, three are emphasized: exclude unnecessary personnel; rescue affected personnel; remove radiation source and determine doses received. (H.B.G.)

22310 MEDICAL RADIATION MONITORING IN THE BAVARIAN FREE STATE. Zimmer, R. (Bayerisches Landesinstitut fuer Arbeitsmedizin, Munich). pp 18-20 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Medical supervision and monitoring of personnel working under radiation hazards are reviewed for the state of Bavaria. Emphasis is put on the fact that safety measures are constantly being improved upon as more information becomes available. Maximum efficiency requires cooperation of qualified physicians, physicists, and chemists. (H.B.G.)

22311 PRECAUTIONS IN A RADIATION INCIDENT. Pohl, W. (Staatsministerium des Innern, Munich). pp 10-13 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Accidents in jobs related to peaceful uses of atomic energy are rare but cannot be excluded entirely. Three different aspects of radiation incidents are discussed: preventive measures in large plants as well as smaller places where danger of accidents exists; steps to be taken in cases of such accidents from the transporting of patients to the actual treatment in hospitals equipped with nuclear medicine centers; test drills for increased efficiency and training of personnel. (H.B.G.)

22312 A FINITE PLUME MODEL BASED ON WIND PERSISTANCE FOR USE IN ENVIRONMENTAL DOSE EVALUATION. Shirvaikar, V. V.; Kapoor, Ramesh K.; Sharma, L. N. (Bhabha Atomic Research Centre, Bombay). Atmos. Environ., 3: 135-44 (Mar. 1969).

A realistic evaluation of dosages from continuous sources (such as nuclear reactors) should use finite wind direction persistence. A plume model for release in finite wind persistence is developed. Relations are derived for computing dosage during the period of persistent wind direction, and that due to the transit of the oblique plume in the changed wind direction at the end of the persistence period. The derivations take into account the change in diffusion conditions before and after the wind direction change. Some approximate relations are compared with the numerically integrated dosages computed on a CDC3600 computer. It was found that the agreement was quite satisfactory. (auth) (UK)

22313 RADIATION CONTROL FOR HEALTH AND SAFETY ACT OF 1968. Lazell, J. A. (Bureau of Environmental Control Administration, Rockville, Md.). Health Phys., 16: 525-6(Apr. 1969).

A summary of the provisions of this Act, the purpose of which is to protect the public from unnecessary exposure to harmful radiation from electronic products, is given. The main provision is for the establishment of an electronic product radiation control programme, including the development and administration of performance standards with regard to radiation emission, and the undertaking by public and private organizations of relevant research and investigation. (UK)

22314 DEPOSITION OF AEROSOL PARTICLES IN THE NASOPHARYNGEAL REGION OF THE HUMAN RESPIRATORY TRACT. Hounam, R. F.; Black, A.; Walsh, M. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 221: 1254-5(Mar. 29, 1969).

Some preliminary experimental work at AERE on the behavior of inhaled radioactive aerosol particles in the respiratory tract of some volunteer subjects is described. The aerosols were drawn through the nose and mouth at flow rates of 5 to 40 l/min. Monodisperse polystyrene particles of diameter 1.6 to 7.3 μm and labeled with ^{82}Br were employed in the studies. The ^{82}Br activity was measured by γ-ray spectrometry on filters before and after passage through the nose and mouth. The results broadly confirmed the accepted relationship between deposition, rate of flow, and aerodynamic particle size, although considerable scatter was found. A graph is shown for the deposition N plotted against $\underline{D}^2\underline{F}$, where $\underline{D}$ is aerodynamic diameter and $\underline{F}$ is flow rate; this graph represents the function $\underline{N} = -0.62 + 0.475 \log D^2F$. A continuous record was made of the drop in pressure across the nose and mouth during each experiment, and a graph is shown of $\underline{N}$ plotted against $\underline{D}^2\underline{R}$, where $\underline{R}$ is the resistance across the nose and mouth. The correlation is considerably better than in the first graph, especially for large depositions. It was found that different subjects gave slightly different curves. (UK)

22315 RADIOACTIVE DECONTAMINATION OF EDIBLE MUSHROOMS BY BLANCHING. Rohleder, Karsten (Staatliche Chemische Untersuchungsamt, Brunswich). Ind. Obst -Gemuseverwert., 52: 64-6(Feb. 2, 1967).

The practical and economic feasibilities of removing radioactive fallout contamination from processed edible mushrooms are discussed. The major radioactive contaminant in mushrooms is ^{137}Cs. The ^{137}Cs content was decreased by ~50% as based on dry wt after 10 min blanching in H_2O. The decrease amounted to 75% after 10 min blanching in 2% NaCl solution. The ^{90}Sr contained in the mushrooms decreased to 70% after 5 min blanching in H_2O, but increased to 100% when the blanching time was increased to 10 min. However, when the mushrooms were blanched in NaCl solution for 5 and 10 min the ^{90}Sr content decreased to 80 and 25%, respectively. Washing the mushrooms with 1% citric acid solution for 5 min decreased the ^{137}Cs by 9%. Blanching of the mushrooms in baskets for 5 min removed 12% of the ^{137}Cs originally present. (BBB)

22316 RADIATION BURDEN OF AN INDUSTRIAL POPULATION. Bugyi, Balazs (Ganz-Mavag Hospital, Budapest). Vitalst. Zivilisationskr., 12: 93-4(1967). (In German).

The frequency of thoracic, gastric, and intestinal fluoroscopies, and surface irradiation, bone marrow, and gonadal doses were compiled and reported for the years 1959 to 1965, inclusive, for an industrial population of a metallurgical plant. The radiation burdens from fluoroscopies and radiographs amounted to total surface doses of ~490,000 R, total gonadal doses of ~1600 R, and ~10,100 R in bone marrow doses. These values were considered to be excessive in terms of the numbers of persons treated over the time period of the study. Radiation burdens were evaluated in terms of type of irradiation study used, working days, and numbers of personnel involved. (TSS) (BBB)

22317 SAFE LEVELS OF RADIOACTIVITY IN AQUATIC ENVIRONMENTS. Wolfe, D. A.; Rice, T. R. (Radiobiological Lab., Beaufort, N. C.). Scientia (Milan), 103: 469-87(Sept.-Oct. 1968).

The implications of radioactive waste disposal into aquatic environments, and those aspects of radiation physiology, radioecology, and health physics used in developing standards for the adequate protection of aquatic ecosystems and man from excessive doses of radiation, are discussed. Methods for calculation of maximum permissible concentrations of ^{65}Zn in drinking water are presented. Evidence that some current assumptions on ^{65}Zn accumulation and retention are not necessarily exact for accumulation from various foods is presented. Differences in efficiency of ^{65}Zn assimilation related to transport across the mucosa that is facilitated by the presence of protein in the gut are described. Protein content of food and uptake of ^{65}Zn from different sources are tabulated. A conventional derivation of working limits (DWL) for radioactivity in the marine environment is outlined. The DWL assumes that the efficiency of accumulation and retention and also the final tissue distribution are the same whether the isotope is ingested in drinking water or food. Several DWL values derived by conventional and specific activity methods for ^{60}Co, ^{59}Fe, ^{64}Cu, ^{65}Zn, ^{137}Cs, ^{90}Sr, ^{131}I, ^{32}P, ^{35}S, and ^{45}Ca are compared. (BBB)

Medicine

Refer also to abstracts 21941, 21943, 22150, 22191, 22277, 22289, 22316, 22427, 22430, and 22431.

22318 (AEC-tr-6944, pp 581-91) PHYSICOCHEMICAL APPROACH TO THE SELECTION OF ORGANIC COMPOUNDS DESIGNED TO ELIMINATE RADIOACTIVE SUBSTANCES FROM THE ORGANISM. Balabukha, V. S.; Tikhonova, L. I.; Razbitnaya, L. M.; Smolin, D. D.; Razumovskii, N. O.; Torchinskaya, O. L. Translated from pp 462-70 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Synthetic complex-forming agents may be used to help eliminate from the body radioactive isotopes of alkali-earth, rare-earth, and heavy elements found in the products of nuclear fission. Biological data on their effectiveness and the physical chemistry of some of these compounds are reviewed. On parenteral administration of N,N,N′,N′-tetraacetic acid of diaminediethyl ether (DEETA) and N,N,N′,N′-tetraacetic acid of diamenediethyl sulfide (DESTA) to rats the build-up of strontium in the skeleton was 25 and 6% respectively. Rare-earth elements display the following physicochemical features of complex-formation. They form highly stable complexes with many organic compounds, much stronger than the complexes of alkali-earth elements. Their strength pattern is the same as for alkali-earth elements, i.e., the strongest complexes are those formed with oxygen-containing ligands. The uranyl ion forms less stable complexes than the rare-earth elements. DESTA markedly increases the elimination of uranium from the rat and reduces its build-up in the organs. Zirconium, like the alkali- and rare-earth elements, forms more stable complexes with oxygen-containing ligands. Ruthenium, on the other hand, displays a different selectivity with respect to donor atoms. This element forms the most stable complexes with sulfur-containing ligands, followed by compounds containing the donor atoms N and O. Thus, DESTA and certain other complex-forming agents of the dithiol type are more effective than DEETA and diethylenetriaminepentaacetic acid (DTPA) in forming stable complexes with ruthenium. Biological experiments with ^{106}Ru, ^{95}Zr and ^{95}Nb show that 2-propanol-1,3-diaminetetraacetic acid is an effective compound. Biological experiments warrant the conclusion that the ligands considered can be ranked in the following order of effectiveness with rare-earth elements: DTPA > DEETA > ethylenediaminetetramethylphosphinic acid (EDTA). Investigation of the phosphine analogues of polyamino-polyacetic acids shows that the stability of the complex of $^{3+}$Y with EDTA in the living organism is not as strong as the complex of this element with ethylenediaminediacetic dimethylphosphinic acid but stronger than the complex of $^{3+}$Y with ethylenediamenetetramethylphosphenic acid. Physicochemical explanations are given for the complex-forming properties of the compounds described. (M.M.B.)

22319 (AEC-tr-6944, pp 615-21) EFFECTIVENESS OF THE PHOSPHINE ANALOGUES OF COMPLEX-FORMING AGENTS IN ELIMINATING ^{91}Y AND ^{144}Ce FROM THE ORGANISM OF THE RAT. Torchinskaya, O. L.; Razumovskii, N. O.; Mironova, E. A. Translated from pp 488-94 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effectiveness of certain polyaminopolyphosphinic compounds in accelerating the elimination of ^{91}Y and ^{144}Ce by rats was investigated. The following acids were tested: ethylenediaminetetramethylphosphinic (EDTP), diethylenetriaminepentamethylphosphinic (DTPP) and tetramethylphosphinic acid of β,β'-diaminediethyl ester (DEETP). These acids are analogues of the known chelating compounds: ethylenediaminetetraacetic acid (EDTA), diethylenetriaminepentaacetic acid (DTPA), and tetraacetic acid of β,β'-diaminediethyl ether (DEETA), in which the carboxylic groups are completely substituted with phosphinic groups, as well as of ethylenediaminebisacetic-bismethylphosphinic acid (EDPA). For biological tests, 10% solutions of monocalcium-sodium salts (pH = 7.3) were used, except for EDPA which was used in the form of ammonium-calcium salt. The tests were carried out on male rats which were at the same time intraperitoneally injected with ^{91}Y or ^{144}Ce in the form of chloride without a carrier, at the rate of 0.1 μCi/g. To compare the different agents, the tested solutions of phosphinic analogues were also injected in single intraperitoneal doses. The compounds were administered in their maximum tolerable doses either simultaneously with the injection of ^{91}Y or ^{144}Ce or prophylactically before that injection or soon after that injection. It was found that partial substitution of the carboxylic groups with phosphine groups enhanced the effectiveness of the agent, as exemplified by EDTA versus EDPA. On the other hand, compounds in which the carboxyl groups were completely substituted with phosphine groups were less effective, as exemplified by EDTP, DEETP, and DTPP, since their use resulted in a greater build-up of ^{91}Y and ^{144}Ce in the rats. Apparently, the formation of complexes between radioactive isotopes and the phosphine analogues of polyaminopolyacetic acids in which the carboxyl groups are completely substituted with phosphine groups involves spatial complications which affect the strength of the complexes they form with yttrium and cerium. (M.M.B.)

22320 (AEC-tr-6944, pp 626-40) EFFECTIVENESS OF HEMODIALYSIS IN POISONING WITH INCORPORATED ^{90}Sr. Petrovnin, M. G. Translated from pp 497-509 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Application of the artificial kidney after five minutes as well as after one, two, and four hours following lethal poisoning of dogs with incorporated ^{90}Sr is not contraindicated, even though a state of artificially induced hemophilia had to be maintained in the experimental animals during the six hours of hemodialysis. Six-hour utilization of only 27% of the dialyzing surface of the Soviet-built artificial kidney made it possible to eliminate from the organism 25.7 to 47% of the ^{90}Sr administered to the animals. The amount of radioactive strontium depositing in the caudal vertebrae then correspondingly decreased and the survivability of the experimental animals increased. The amount of ^{90}Sr eliminated from the organism is directly proportional to the duration of hemodialysis and concentration of the isotope in the blood. (tr-auth)

22321 (AEC-tr-6944, pp 688-96) CLINIC OF RADIATION POISONING CAUSED BY ^{210}Po AND THE EFFECT OF TREATMENT WITH SULFATHIOAZOLE. Dunaev, V. V. Translated from pp 546-53 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Data on the therapeutic effectiveness of sulfathiazole in the ^{210}Po-poisoned organism are presented. Radiation sickness was produced in rats with a single-dose subcutaneous injection of 0.03 μCi/kg of ^{210}Po. The daily dose of sulfathiazole (200 mg/kg) was divided into three parts and perorally administered in the form of suspension at intervals of three hours each. Treatment was begun at various periods of radiation sickness: the first series, four days before and four days after poisoning; the second series, first 8 days of disease; the third series, from 8th until 15th day of disease; the fourth series, from 15th until 23rd day of disease. The animals, both those receiving and those not receiving therapy, developed a typical picture of radiation sickness with all of its attendant clinical symptoms. However, a comparison of the dynamics of the radiation process in the ^{210}Po-poisoned rats of the control group and in the rats which also were poisoned with ^{210}Po but received therapy, revealed that the sulfanilamide drug somewhat assuaged the course of the disease. Thus, while about 40 percent of the controls died on the 20th day of the disease, only 20 percent died in all the groups receiving treatment (except 10% for the group which received treatment beginning with the first day of disease). Subsequently, mortality sharply increased and on the 40th to 50th day of disease it reached 100 percent in all the investigated groups of animals. The average life-span of the animals was the same regardless of whether they received or did not receive treatment. The administration of sulfathiazole also affected the dynamics of weight loss in the ^{210}Po-poisoned animals. Thus, while in the control group weight loss commenced on the 10th day, in the groups of animals receiving treatment the onset of weight loss occurred a week later and its course was less sharp, except in the animals receiving sulfathiazole beginning with the 16th day since poisoning with ^{210}Po. The administration of the drug to animals in experimental groups 1 and 2 resulted in a change in the nature of the leukocytic curve. Sulfathiazole did not depress leukopoiesis during the first days of the disease or even during its climax and, instead of reducing the lifespan of the animals, somewhat assuaged the clinical course of the disease. (M.M.B.)

22322 (NYO-3086-8) RADIOACTIVITY STUDIES. Annual Report, October 1, 1967-September 1, 1968. Eisenbud, Merril; Wrenn, McDonald E. (New York Univ., N. Y. Inst. of Environmental Medicine). Contract AT(30-1)-3086. 261p. Dep. CFSTI.

Separate abstracts were prepared for 10 of the 11 papers presented. The one remaining paper was not sufficiently within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 21619, 21807, 21937, 22186–22188, and 22287–22290.

22323 VISUALIZATION AND FUNCTION STUDIES OF THE CEREBROSPINAL FLUID SPACE WITH ^{99m}Tc–SULFIDE COLLOID. Wellman, H. N.; Lewis, H. P.; Carroll, R.; Ramirez, R. (Univ. of Cincinnati). Neurology, 18: 1113-19(Nov. 1968).

A method was developed to visualize the cerebrospinal fluid (CSF) space. Assessment of available radiopharmaceutical agents showed that ^{99m}Tc–sulfide colloid offered ideal characteristics. Intrathecal or intraventricular injection of ^{99m}Tc–sulfide colloid in 15 monkeys and 12 cats is described. Doses varying from 0.3 to 2 mCi were utilized. Scintigraphy was used, and serial blood and CSF specimens were obtained in order to study the fate of the isotope. The ^{99m}Tc–sulfide colloid possesses physical properties which allow it to maintain a high CSF : blood ratio and which produce a high photon yield with a low patient dose. Volume computations of total CSF and subarachnoid spaces seem to be feasible. Subarachnoid space scintigraphs of good detail can be produced with this agent by either intraventricular or subarachnoid injection. Physical properties do not favor settling of the isotope out of the CSF gravitational effect. No obvious adverse reactions were noted in animals receiving this agent. (BBB)

22324 CASE OF AFFECTION WITH CESIUM RADIOACTIVE ISOTOPES. Kirillov, S. A.; Vissonov, Yu. V. (Kharkov Inst. of Medical Radiology). Med. Radiol., 13: No. 12, 20-5(Dec. 1968). (In Russian).

A case of acute radiation sickness of moderate severity due to 5 ± 1 mCi of ^{134}Cs and ^{137}Cs is described. On the 95th day of the disease the dose of internal irradiation was 130 RAD. The course of the acute radiation sickness, therapeutic measures instituted, and the expediency of the therapeutic complex are described. (auth) (C.O.)

22325 STUDIES OF SEVEN CASES DIABETIC RETINOPATHY TREATED BY INJECTIONS OF ^{90}Y. Dossi, F.; Chiavazza, G. (Centro Ortottico, Turin). Minerva Med. Giuliana, 8: 196-201 (May-June 1968). (In Italian).

In seven cases of diabetic retinopathy of various degrees of gravity, an improvement of vision and of the ocular background was seen after the injection of ^{90}Y. The improvement was conspicuous and lasting in four cases; in one case after a great initial improvement there was a retinovitreal hemorrhage in the right eye which seriously compromised the visual capacity of the eye, whereas in the left eye, affected with a cataract, the vision underwent no variation. In two cases with very grave condition of the retina, there was no hope of significant improvement, but there was an increase of vision in one case and an appreciable improvement of the state of the ocular background. (tr-auth)

22326 LUNG: THE CHALLENGE OF NUCLEAR MEDICINE. Quinn III, James Leland (Northwestern Univ., Chicago). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 251-9(Feb. 1969).

Lung scanning represents a challenge to nuclear medicine on several fronts. It is a challenge to become expert in the current knowledge of pulmonary pathophysiology. A further challenge is to improve diagnostic technique at all levels. The radiopharmaceutical preparation is far from ideal. Better quality control of particle size is needed, perhaps through the recently discovered metabolizable microspheres to which radionuclides are adsorbed; and an improvement of detecting crystals, to replace sodium iodide. Encouraging work on lead fluoride crystals has been done. A clear definition of the advantages of camera versus scanner should be stated, accepted and applied. Uniformity of readout should be sought. The final challenge is in the area of communication between medical and physical science researchers. (TSS) (auth)

22327 AN OCCURRENCE OF OSTEOMYELITIS OF THE UPPER JAW AFTER X IRRADIATION FOR FACIAL LUPUS. Glasenapp, G. Benita (Hals-Nasen-Ohren-Klinik, Magdeburg, Ger.). HNO, 16: 46-9(Feb. 1968). (In German).

A case of osteomyelitis of the upper jaw with ulceration of the soft tissue of the cheek, that appeared 30 yr after irradiation of the face with an undetermined dose of x ray, is reported. Examination of the maxillary sinus, mouth, and ulcerated area showed necrosis, purulent exudate, nonspecific granulation tissue, inflamed, hyperplastic sinus mucosa with mixed cell inflammation, but no evidence of tuberculous granulations and no tumor cells. After radical surgery and removal of sequestered bone the defect healed over a period of 1 yr, and was then repaired by plastic surgery. The interval between the intensive irradiation and the appearance of the osteomyelitis was very long. There was no clear evidence of facial lupus, and the osteomyelitis appeared to be due to the irradiation received, although it was not manifested until after the irradiation site became infected. (BBB)

22328 INDICATION AND RESULTS OF ^{90}Y IMPLANTATION IN THE HYPOPHYSIS IN CUSHING'S SYNDROME. Nadjmi, W.; Boerner, W.; Husmann, F. (Univ., Wuerzburg, Ger.). Acta Neurochir., 16: 313(1967). (In German).

Results of ^{90}Y hypophyseal implantation in six patients are reported. The best indication for use of ^{90}Y was in patients with renal cortical hyperplasia, and cortical adenomas, carcinomas, or extrarenal carcinomas. The activity of the implanted ^{90}Y ranged from 3.4 to 10 mCi. In one patient implanted with 10 mCi in two needles, cortical insufficiency developed, which was normalized by single administration of cortisone. The results from the younger patients treated with ^{90}Y implantation indicated that the procedure should not be carried out at the expense of a falling off in hormone levels. As a rule, the implantation of a single needle with an activity of 3 to 5 mCi should be sufficient to achieve optimal results. (BBB)

22329 AERZTLICHE MASSNAHMEN BEI AUSSERGEWOEHNLICHER STRAHLENBELASTUNG. INFORMATIONSTAGUNG DER GESELLSCHAFT FUER STRAHLENFORSCHUNG m.b.H. UND DER VEREINIGUNG DEUTSCHER STRAHLENSCHUTZAERZTE e.V. IN FREIBURG i. Br. am 26. UND 27. OKTOBER 1966. (Medical Measures for Unusual Radiation Burdens. Information Meeting of the Society for Radiation Research mbH and the Union of German Radiation Protection Physicians, Freiburg, October 26–27, 1966. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. 143p. $4.95. (In German). (CONF-661057).

Twenty-five papers were presented; separate abstracts were prepared for each. (H.B.G.)

For abstracts of individual papers see: 22257, 22303–22311, 22330–22340, 22402, and 22427–22429.

22330 MODIFICATION OF RADIATION EFFECTS BY CHEMICAL SUBSTANCES. Langendorff, H. (Univ., Freiburg i. B.). pp 66-70 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Prophylactic administration of chemical substances to lower the effects of radiation injury is discussed. Data of animal experiments in the area of chemical prophylaxis are briefly reviewed. It is pointed out, however, that administration of chemicals (examples given are: 5-hydroxytryptamine, chlorotrianisene, β-aminoethylisothiuronium, and cysteamine) after irradiation is totally ineffective. Animal experiments with nucleic acids indicate the possibility of post-irradiation beneficial effects. (H.B.G.)

22331 TREATMENT OF THE RADIATION INJURY OF THE SKIN. Kaercher, K. H. (Univ., Heidelberg). pp 94-8 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Modern safety measures minimize radiation exposure in routine clinical and industrial procedures. Acute high dose radiation burns of the skin are discussed. Therapeutic measures are largely determined by type of radiation, dose rate, and accumulated dose. Treatment with oil-based ointments as well as with powders is discussed from results obtained from animal experiments. After the extent of skin damage has been established, surgical instead of conservative treatment is recommended. (H.B.G.)

22332 ACUTE RADIATION DAMAGE OF THE SKIN AND EXTERNAL DECONTAMINATION. Born, W. (Univ.-Hautklinik, Freiburg i. B.). pp 81-94 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Radiation induced skin damage and ensuing treatment are discussed. After exposure to high doses the skin, owing to its radiosensitivity, requires both therapeutic measures and prophylactic procedures against possible complications. Dose rate is an important prognostic factor. Recommended is treatment similar to burns; the use of antibiotics is emphasized. Safety measures for avoidance of skin exposure to radiation are discussed. In the case of accidents radioactive material must be removed immediately from the skin. Precautions must be taken that the removal procedures will not facilitate the entrance of radioactive material into the body. Relevant literature is comprehensively reviewed. (H.B.G.)

22333 RADIATION INCIDENT AS THE PROBLEM FOR A MEDICAL GROUP WORK. Fliedner, Th. M. (EURATOM, Freiburg i. B. Medizinisch-Naturwissenschaftl., Hochschule, Ulm, Ger.). pp 1-9 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Basic principles of radiation damage on the human as well as the animal organism are discussed. The goal of the conference was to give practical guidelines for diagnosis, evaluation, and treatment of radiation induced disorders of normal body functions. In order to increase efficiency of treatment, group work among clinicians in cases of radiation accidents is necessary. Three steps of measures in cases of usual radiation burdens are suggested: first aid stations in places of potential danger; ambulance station manned by physicians for determination of damage and first treatment; fully equipped easily accessible treatment and care center. The importance of educating the public through medically qualified people is emphasized. (H.B.G.)

22334 URGENT SURGERY IN RADIATION INCIDENTS. Koehnlein, H. E. (Univ., Freiburg i. B.). pp 71-4 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Surgical problems related to radiation injury are discussed. Consideration of surgery enters the radiation injury picture primarily in combination injury cases. Swine, exposed to atomic explosions, were used in experiments to determine effects of surgical procedures in combination injury cases. In cases of radiation and burns mortality increased over strictly radiation injury; however, other wounds in combination with irradiation did not increase mortality. Healing of wounds contracted after irradiation was prolonged 15 to 20 days over nonirradiated animals. Tissue defects and fractures, combined with radiation injury, should receive routine definitive treatment; whereas, in burns the definitive treatment should be delayed. (H.B.G.)

22335 CLINICAL EVALUATION AND TREATMENT PRINCIPLES. Wendt, F. (Evang. Krankenhauses, Essen-Werden, Ger.). pp 27-35 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Various aspects of the acute radiation syndrome are reviewed. Dose level determines the different stages of radiation sickness as described in a table with dose levels from 100 rad to above 1600 rad leading to diagnostic evaluation and therapeutic principles. (H.B.G.)

22336 ANTIBIOTIC THERAPY IN EXTRAORDINARY RADIATION BURDEN. Wiskemann, A. (Univ., Hamburg). pp 63-6 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Application of antibiotics in the acute radiation syndrome, especially in whole body irradiation, is discussed. Resistance and allergic reactions to certain antibiotics have to be considered. Prophylactic measures for germ free conditions are recommended. The clinical picture determines onset of antibiotic therapy; recommended minimum for treatment is ten days. (H.B.G.)

22337 PROPHYLAXIS AND THERAPY OF MICROBIAL COMPLICATIONS IN UNUSUAL RADIATION BURDEN. Moessner, G. (Univ., Freiburg i. B.). pp 53-61 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

The gastro-intestinal and bone marrow syndrome represents an important factor in the low resistance level to infections after radiation injury. Animal experiments indicate that the degree of granulocytopenia determines mortality rate. Antibiotic therapy in various types of infections is discussed as well as resistance level of bacteria against antibiotics. Prophylactic measures in acute radiation injury are recommended. (H.B.G.)

22338 POSSIBILITIES OF SUBSTITUTION THERAPY WITH BLOOD CELLS: FROM THE VIEWPOINT OF THE BLOOD TRANSFUSION SERVICE. Haussmann, H. G. (DRK-Blutspendedienstes Baden-Wuerttemberg, Baden, Ger.). pp 61-3 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

The importance of blood cell substitution in relation to blood transfusion services is discussed. Long term preservation of blood cells is essential in cases of radiation catastrophies. Few experimental data relating to blood cell concentrates are available; research programs in cooperation with hematology, cytology, biochemistry, and biophysics are recommended. (H.B.G.)

22339 INDICATION AND CARRYING OUT OF SUBSTITUTION OF VARIOUS TYPES OF BLOOD CELLS. Heimpel, H. (Med.-Naturwissenschaftl. Hochschule Ulm, Ger.). pp 43-52 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Substitution of various types of blood cells in relation to different stages of radiation injury is discussed. Total blood transfusion is not recommended. Experimental and clinical evaluations in blood cell changes after radiation injury are briefly reviewed. Timing of substitution therapy depends largely on the thrombocyte count and on the danger of acute bleeding. Erythrocyte substitution is indicated in radiation induced anemia. Because of technical difficulties, granulocyte substitution is recommended only in extreme infection cases. Several tables give evaluation of blood cell changes after radiation injury. (H.B.G.)

22340 DISTURBANCES OF ELECTROLYTE AND WATER BALANCE IN ACUTE RADIATION INJURY. Hallauer, W.; Schirmeister, J. (Univ., Freiburg I. B.). pp 35-43 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

The gastro-intestinal type of the acute radiation syndrome is reviewed. Therapeutically, the following measures are proposed: replacement of losses of water, electrolyte, and blood; administration of antibiotics and relief of abdominal distention by gastric suction. Twenty-eight references are given. (H.B.G.)

22341 PULMONARY SCINTILLATION SCANNING. Cardellino, G.; Micheletti, P. C.; Stratta, P. (Univ., Turin). Minerva Med., 59: 5497-5502(Dec. 12, 1968). (In Italian).

A critical appraisal of the results and value of pulmonary scintillation scanning with MAA ^{131}I was made on the basis of the data reported in the literature and of the authors' personal experience in a large number of cases. The main types of scintigraphic changes are described: the absence of the contrast medium in a more or less large area of the lungs is typical of pulmonary embolism and bronchial cancer; in cases of pulmonary emphysema, chronic bronchitis, hypertensive pulmonary vascular disease the distribution of the radioactive substance is uneven; a concentric reduction of the pulmonary scintigram, more difficult to interpret, is associated with pulmonary fibrosis. (tr-auth)

22342 SCINTIPHOTOGRAPHY OF THE NORMAL SKULL USING ^{99}Tc–PERTECHNETATE. Keyeux, A. (Univ., Louvain, Belg.). J. Belge Radiol., 51: 318-28(1968). (In French).

With conventional scanning devices the number of views in brain scintigraphy is usually limited to anteroposterior and lateral views. It is shown that seven more views can be investigated during the same time period, with the simultaneous use of a scintillation camera and ^{99m}Tc. Illustrations of a normal brain are presented and diagnostic applications of the method are outlined. (auth)

22343 MANAGEMENT OF FUNCTIONING THYROID CANCER. Hales, Ian; Reeve, Tom; Johnson, David (Royal North Shore Hospital, Sydney). Med. J. Aust., 1: 372-7(Feb. 22, 1969).

The ability of malignant tissue to simulate normal thyroid tissue can be demonstrated by using radio-iodine tracers. A lesion must be at least in part follicular before it can be considered likely to function. Management of the condition is confusing. Many patients are young and unnecessary radiation should be avoided. Ten case histories are given and in most of them, after total thyroidectomy, some functioning remnant has been detected in the neck by scanning using a dose of 2 to 5 mCi of iodine-131. Treatment includes 150 mmCi doses of iodine-131 whenever residual lesions are not suitable for surgery, or distant metastases are demonstrated. Radiation risk from therapeutic doses is definite but repeated doses add little to the bone marrow dose. (Australia)

22344 ORAL CANCER IN AUSTRALIA. Tan, K. N. (Univ. of Sydney). Aust. Dent. J., 14: 50-6(Feb. 1969).

There were 5754 patients with oral cancer registered in the major hospitals in Australia for the years 1959 to 1964 inclusive. This gives a rate of about 9.1 per 100,000 population per year. There was a significant decrease in the number of new cases and in the rate per 100,000 population of patients with the disease over the six years. Oral cancer is a disease of men, the males to females ratio being 3.7 : 1. It is a disease of the aged. The average age and median age of patients with the disease were 59.8 and 61.4 years respectively. The lip was the most common site of the disease, accounting for about 62 per cent of the cases, the next most common site was the tongue. Squamous cell carcinoma comprised the main histopathologic type of cancer of the mouth (at least 80 per cent of cases). Radiotherapy was used more frequently (66.8 per cent) than surgery (26.6 per cent) in the treatment of patients with primary oral cancer in Australia, whereas the reverse was true in the choice of therapy for cervical metastatic lymph nodes. The crude five-year survival rate for male patients with cancer of the intraoral cavity proper (excluding the lip) was 30.3 per cent, and that for female patients was 35.7 per cent. (Australia)

22345 HAZARDS OF RADIATION IN OBSTETRICS AND GYNECOLOGY. Lutterbeck, Eugene F.; Hummon, Irvin F. (Cook County Graduate School of Medicine, Chicago). Ill. Med. J., 130: 299-307(Sept. 1966).

Some of the basic principles of radiation protection that play such a vital role in obstetrics are discussed. Somatic changes can be ignored with modern diagnostic equipment and technique and only the genetic hazards must be considered. To avoid excessive hazards of diagnostic radiation, it is essential to comply with present protective requirements which deal with specifications of equipment in regard to tube housing, collimation, coning, filtration, target distance, screen shielding, and protective barriers. Hazards of therapeutic radiation in gynecology are also considered. The doses used for benign conditions are relatively low, the treatment of malignancies in gynecology presents difficult problems. Since the destruction of a cancer cell requires an average of 6000 RAD, modern radiotherapy aims to deliver that dose to the tumor within six to seven weeks, without, if possible, causing irreversible damage to the healthy tissue. With a malignancy, genetic effects have to be disregarded as far as the patient is concerned, because doses over 1000 R to the ovaries will produce permanent sterilization. The hazards lie in possible overirradiation of healthy tissues, but even more in the undertreatment of the malignancy. Calculation and measurement of therapeutic doses are described. Prevention of excessive exposure of radiologists, nurses, and other personnel is also dealt with. (BBB)

22346 THE EFFECT OF RADIOTHERAPY ON PLASMA LIPIDS IN CANCER PATIENTS. Marques, P.; Douste-Blazy, L.; Carton, M.; Landreaud, B. (Hopital de la Grave, Toulouse). Bull. Cancer, 55: 205-14(Apr.-June 1968). (In French).

Plasma lipids were estimated before and after radiotherapy in three groups of patients: subjects receiving ^{60}Co irradiation of the mediastinum or abdomen for esophageal or vesical cancer, respectively, subjects irradiated with ^{60}Co for cerebral tumors, and subjects treated intraperitoneally with ^{198}Au for ascites neoplasia. The ^{60}Co tumor dose was 5000 RAD, and the ^{198}Au dose was 150 mCi that delivered 4000 to the serous peritoneum, 750 RAD to the abdominal viscera, and 10,000 to 30,000 RAD to the lymph nodes. Patients who had ^{60}Co treatment to the head region underwent an increase of total plasma lipids, phospholipids, and esterified fats. Those treated with ^{198}Au showed a greater degree of hyperlipemia than the ^{60}Co-treated patients. In all the irradiated patients the plasma contained a significant amount of peroxidolipids that begin to appear in the early stages of irradiation. Peroxidatin of linoleic acid and arachidemic acid of plasma lecithins may be involved here. (BBB)

22347 RADIATION DEPIGMENTATION OF MOUSE HAIR: THE INFLUENCE OF LOCAL TISSUE OXYGEN TENSION ON RADIOSENSITIVITY. Potten, Christopher S.; Howard Alma (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Radiat. Res., 38: 65-81(Apr. 1969).

Experiments were conducted on Strong F or DBA-1 mouse skin in telogen (resting stage) to determine the effect of local tissue oxygen tension on sensitivity to 300-kVp x-rays. Radiation response was measured by counting the proportion of pigmented follicles, and the results were expressed as dose-response curves. During irradiation, the vascular and environmental oxygen supplies were controlled by the use of a skin-fold technique and a vascular clamp. By applying a clamp and passing nitrogen over the skin for 15 minutes prior to irradiation, sensitivity could be reduced by a factor of 2.89 from the maximum obtained in pure oxygen. When the only supply of oxygen was by diffusion from pure oxygen outside the skin, sensitivity was near maximum, indicating appreciable diffusion to a depth of 200 to 300 microns. When air was the external source of oxygen, sensitivity was near minimum, indicating that little oxygen diffuses to this depth from air. The sensitivity under normal conditions, in air with no clamp, was slightly lower than that obtained in pure oxygen. (auth)

22348 PROTECTIVE EFFECT OF O-(BETA-HYDROXYETHYL)-RUTOSIDE AGAINST RADIOINDUCED INHIBITION OF ENERGY METABOLISM. Fritz-Niggli, Hedi (Univ., Zurich). Praxis (Bern), 57: 180-3(1968). (In German).

The experiments described show that O-(β-hydroxyethyl)-rutoside (HR) attenuates, and sometimes counteracts completely, the detrimental effect of aging, irradiation, and iodoacetamide upon oxidative phosphorylation in isolated mitochondria of rat livers. These findings open new possibilities for using HR as a selective agent to protect healthy tissues against the effect of radiation, because in most cases normal cells contain more mitochondria than tumor cells. The role of flavonoids in the chain of respiration ferments on the radioprotective action of HCR was suggested. Furthermore, there is a chance that HR attenuates changes in permeability caused by irradiation or aging, as the enzyme activity of mitochondria may be influenced by variations in permeability. A comparative study, presently in progress, on single components of HR, may further elucidate the question. The stabilizing effect of HR in disorders of cell metabolism might help to interpret earlier findings and offer interesting new possibilities for clinical application. (F.M.M.)

22349 RADIOSENSITIZATION OF KB CELLS IN VITRO BY HYDRAZINE DERIVATIVES. Thayer, P. S.; Carey, P. G.; Carpenter, A. McM; Mazuy, K. K. (Arthur D. Little, Inc., Cambridge, Mass.). Radiat. Res., 38: 161-72(Apr. 1969).

Acid hydrazides have been found to have apparent sensitizing activity on the effects of 300-kV x-rays on survival of KB cells in culture. "Active" compounds, as measured by survival modification factor at a single x-ray dose, include the hydrazides of the following acids: acetic, succinic, malic, aconitic, 2,5-pyridinedicarboxylic, 4,5-imidazole-carboxylic, and 1,1,3,3-propanetetracarboxylic. Twelve other hydrazides, some closely similar structurally, were without activity. Radiation dose-response experiments with the first four listed hydrazides have shown significant, though not extreme, effects on slopes and dose-modifying factors. If an active hydrazide is added to cells within 15 minutes after irradiation, the effects on survival are equivalent to those observed when the compound is added one-half hour prior to irradiation and remain present through irradiation. It is thus strongly indicated that these compounds affect a recovery process, or that radiation sensitizes the cells to otherwise nontoxic levels of the compounds. (auth)

Radiation Effects on Animals

Refer also to abstract 22349.

22350 LEUKOCYTES WITH DEGENERATIVE DISTURBANCES IN CHRONIC IRRADIATION OF ANIMALS. Keizer, S. A.; Molchanova, M. G. Med. Radiol., 13: No. 12, 53-7(Dec. 1968). (In Russian).

In experiments staged on different animals it was established that the peripheral blood content of leukocytes with degenerative changes depends on the species of animals and their age. Thus, with the advent of age the content of these cells increases and this relation is quite satisfactorily described by an equation. The chronic effect of γ radiation in doses of 0.05 and 0.5 R/day leads to a distinct rise in the number of leukocytes with degenerative changes, which is observed at very early stages of irradiation. There was established a general regularity of changes of these cells in the process of chronic radiation effect. An index for assessing the influence of low doses of ionizing radiation on the organism might then be used for reference. (auth) (C.O.)

22351 IRREVERSIBLE CELLULAR DAMAGE FOLLOWING A COMMONLY EMPLOYED IODINATION PROCEDURE. **Stewart, C. C.; Coopersmith, A.; Ingram, M.** (Univ. of Rochester, N. Y.). J. Nucl. Med., 8: 213-25(Mar. 1967). (UR-49-782).

A procedure for the rapid labeling of intact erythrocytes, thymocytes and lymphocytes with ^{125}I or ^{131}I is described. Labeling efficiencies are as high as 70%. Four factors influencing labeling efficiency are identified, namely number of cells, absolute amount of iodide in constant ratio to chloramine T, chloramine T to iodide ratio, and duration of exposure of cells to reactants. Profound and irreversible cellular damage is observed even when the amounts of reactants employed are less than those used to label soluble proteins without detectable alteration. This cell damage is thought to be caused by oxidation of cellular constituents. Although labeled cells are not viable, the technique may prove useful in preparing labeled particles. (auth)

22352 ENHANCEMENT OF MELANOMA CELL CULTURE GROWTH RATE BY RUBY LASER RADIATION. **Jamieson, Crawford W.; Litwin, Martin S.; Longo, Salvador E.; Krementz, Edward T.** (Tulane Univ., New Orleans). Life Sci., 8: 101-6 (Jan. 15, 1969).

A study was made of effects on melanoma cells in vitro caused by lower doses of laser radiation than those causing instant cell death. Experiments were performed using lightly pigmented B-16 mouse melanoma cells and heavily pigmented human melanoma cells. Low doses of ruby laser irradiation (6943 Å) were found to increase growth of melanoma cell cultures. For example, human cells showed an increase in growth rate over the second 24 hr in culture which was greater after 10 pulses of radiation than after one pulse; at the higher dose level this was statistically significant. There was no evidence of impaired viability in irradiated cultures on vital staining. Control and irradiated cultures always contained less than 10% stained cells 1 hr after treatment, and the number of cells recovered from the irradiated wells was no less than those from the controls. Therefore, no evidence of cell damage was detected at the low doses used. The 24-hr counts from the irradiated cultures were no lower than those from the controls, indicating that plating efficiency remained unimpaired. No gross morphological changes were observed in any of the irradiated cells at any time. When glass was interposed as an uv filter before irradiation, no differences were noted in the observed effect. The overall growth of the irradiated cultures was higher and the effect was still seen over the period from 24 to 72 hr in second generation culture when the primary cultures used were split at 8 days. Since any damaged cells should have been lost from culture by that time, a reduction of the lag phase of growth by damaged feeder cells does not appear likely. On the basis of the observed enhancement of melanoma cell growth in vitro at the power and energy levels used, it is suggested that caution be exercised in the treatment of patients by this means until this phenomenon has been further evaluated. (BBB)

22353 INFLUENCE OF RADIATION OF THE RUBY AND NEODYMIUM LASERS ON THE PIGMENT-FREE CELLS IN THE TISSUE CULTURE. **Gamaleya, N. F.; Pasechnik, O. F.** (Inst. of Experimental and Clinical Oncology, Kiev). Byull. Eksp. Biol. Med., 67: No. 2, 85-7(Feb. 1969). (In Russian).

Irradiation of a monolayer HeLa culture with an impulse ruby laser (wave length 6943 Å) produces two types of cell lesions namely destruction of cellular membranes and formation of foci of radially disposed united cytoplasmic strands. In the formation of foci under the influence of a ruby laser two different factors are presumably responsible: thermal and kinetic. Examination of the structure of foci appearing in the monolayer under the influence of a neodymium laser (wave length 10,600 Å) shows that the kinetic factor is more important. The presence of concentrically disposed arch-like lines in the preparations of calf serum and egg white irradiated by a neodymium laser indicates that a wave process takes place in the irradiated area. In the study of foci irradiated with neodymium laser the formation of cavitations in the irradiated preparations has been noted. (auth)

22354 RADIORESISTANT MUTANTS OF L5178Y CELLS. **Courtenay, V. Doreen** (Inst. of Cancer Research, Sutton, Eng.). Radiat. Res., 38: 186-203(Apr. 1969).

Radioresistant cultures of the L5178Y leukemia were obtained during continuous β-irradiation at 4.8 Rads/hour by means of tritiated water incorporated in the culture medium. The development of radiation resistance in individual cultures after exposures of 39 days or more (total dose $\geq$ 4.6 kRads) was shown to be due to the production of resistant mutants during the course of irradiation. In the resistant cell strains derived from the mutants the chromosome count was unchanged from the modal value of 40, and the ability to grow in the DBA/2 mouse was unchanged. In the absence of radiation, resistant cultures grew rather more slowly than normal cells. Under continuous irradiation the mutants differed from each other in growth rate and in the proportion of dead cells present. The resistant cell strains were maintained at 4.8 Rads/hour for nearly a year, during which the growth rate of the less resistant cultures speeded up in steps corresponding to the occurrence of further mutations, eventually reaching about the same growth rate as the initially more resistant cultures. The mutants initially obtained differed from each other in their response to acute irradiation with x rays at 30 Rads/min and on the basis of their dose response curve could be classified into two groups: those showing an increase in D_q (the dose at the point where the extrapolated exponential part of the curve intersects the abscissa corresponding to 100% survival) and a small increase in D_0, and those showing no increase in D_q and a substantial increase in D_0. The highest survival during continuous irradiation occurred in the group with an increased D_q; this shows that under continuous irradiation at the low dose rate used survival is determined by the properties of the cell reflected in the shoulder of the dose-response curve obtained from acute irradiation rather than the slope. (auth)

Invertebrates

Refer also to abstract 22139.

22355 (CONF-670649-7) USE OF RADIOACTIVE ISOTOPES FOR THE LABELING OF CERATITIS CAPITATA. **Caballero, Fernando; Mellado, Luis; Arroyo, Manuel; Jimenez, Antonio** (Instituto Nacional de Investigaciones Agronomicas, Madrid (Spain)). [1967]. 22p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

Laboratory tests made on the labeling of the fruit fly Ceratitis capitata Wied with ^{32}P were reported. The fruit flies were fed diets with 0.01 and 0.1 mc ^{32}P for each 5 g of feed. The eggs were collected and transferred to another cage. The eggs were allowed to hatch, develop larvae, and finally develop into the pupa and adult stages. The adults were cross bred. The daily breeding, the radioactivity of the eggs, and the radioactivity of the pupae and larvae from the eggs were measured. The results are tabulated and show that the addition of ^{32}P to the diet produces eggs, larvae, pupae, and adults that are all apparently normal. The study of the second generation showed that low radiation doses stimulated the breeding, but higher doses reduced the breeding. All the ^{32}P administered in the diet of the first generation was eliminated in the second generation. (J.S.R.)

22356 THE EFFECT OF WHOLE-BODY IRRADIATION OF 800 R ON THE SUBSTRUCTURE OF THE LABYRINTH OF THE RAT PLACENTA. **Franke, H.** (Friedrich-Schiller-Univ., Jean, Ger.). Gegenbaurs Morphol. Jahrb., 111: 595-604(1968). (In German).

Possible morphological effects of x irradiation on the placenta that could alter materials exchange were studied in rats. Adult rats were given whole-body doses of 800 R on day 17 of pregnancy and killed 48 hr later. Electron- and light microscopic studies showed a delayed growth of the placental labyrinth after irradiation. Substructural changes observed in the trophoblastic cell layer, directly adjacent to the fetal vessels included widespread proliferation of droplike lipid inclusions, a marked increase in membrane development, and destruction of mitochondria. There was no evidence of radioinduced nuclear damage or destruction of trophoblast cells, but numerous erythrocytes with damaged nuclei were observed in the fetal capillaries. (BBB)

22357 PROPERTIES OF A TEMPERATURE-SENSITIVE RADIOSENSITIVE MUTANT OF ESCHERICHIA COLI. **Pauling, Crellin; Hamm, Lyla** (Univ. of California, Riverside). Proc. Nat. Acad. Sci. U. S., 60: 1495-1502(Aug. 15, 1968).

The isolation and characterization of a temperature-sensitive radiosensitive mutant of E. coli is described. Evidence is presented that indicates that the defect in this mutant is in a late step of the dark repair process, possibly in DNA ligase. (auth)

22358 KINETICS OF AGING AS REVEALED BY X-RAY-DOSE–LETHALITY RELATIONS IN DROSOPHILA. Baxter, R. C.; Blair, H. A. (Univ. of Rochester, N. Y.). Contract W-7401-eng-49. Radiat. Res., 30: 48-70(Jan. 1967). (UR-49-735).

Median ages of death following sublethal doses and median lethal doses for acute lethality after one day were determined in relation to age of exposure, throughout normal life span, to 100-kV x rays in Drosophila melanogaster imagoes of both sexes. Both sets of data provide continuously decreasing functions of dose, D, with respect to age. Consequently D may be used as a single valued measure of age, and variations of functions of D with respect to age as rates of aging. Rates of aging as derived from either set of data are faster in the male than in the female and are inversely proportional to normal survival times, about 44 and 51 days, respectively, at the temperature used, 25°C. It is concluded that normal life span and rate of aging are fully determined on eclosion and are realized in the absence of unfavorable conditions. The injuries leading to acute and delayed death appear to affect different mechanisms, the former being wholly recoverable and not additive to the latter, which is irreparable at least in part. Doses below a certain level appear not to shorten life span, and extension of life span by exposure was not observed. (auth)

22359 AGE OF DEATH IN DROSOPHILA FOLLOWING SUBLETHAL EXPOSURE TO GAMMA RADIATION. Baxter, R. C.; Blair, H. A. (Univ. of Rochester, N. Y.). Contract W-7401-eng-49. Radiat. Res., 31: 287-303(June 1967). (UR-49-799).

Ages of death following exposure to ^{60}Co γ radiation were studied for doses permitting survival of at least several days in wild-type Drosophila melanogaster imagoes of both sexes. Lethal injury, represented by $D + 0.003\ D^2$, where D is the radiation dose, is a linear function of the reciprocal of the age of death. The equations for the two sexes differ only in the slope constants, which are proportional to the normal survival times, about 44 and 51 days, respectively, for male and female at 25°C. Average or median life shortening in the two sexes is not equal for a given dose but is the same fraction of normal survival time. Life shortening for various deciles with respect to time of death tends to be equal for the female, but for the male the lives of those dying early are shortened relatively less than the lives of those dying late. Thus the responses of male and female populations are different. In accord with prediction from higher doses, doses below a certain value appear not to affect life span. (auth)

22360 STUDIES ON THE CELLULAR BASIS OF RADIATION LETHALITY. V. A SURVIVAL CURVE FOR THE REPRODUCTIVE INTEGRITY OF THE PLANARIAN NEOBLAST AND THE EFFECT OF POLYPLOIDY ON THE RADIATION RESPONSE. Lange, C. S. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol., 15: 51-64(July 1968).

The experimentally verified model proposed by Lange and Gilbert (1968) quantitatively relates the parameters of the planarian mortality curve to those of the neoblast (planarian stem cell) survival (of reproductive integrity) curve. By use of previously measured values of the constants of the model and the mortality parameters of the members of the Dugesia lugubris auto- or allopolyploid series (2n, 3n, 4n), the neoblast survival curves are determined, and the first direct comparison of the effects of polyploidy on radiosensitivity in animal cells is made. No significant effect of polyploidy on radiosensitivity (D_0) was found. The significantly lower survival of triploids with respect to diploids was found to be caused by extrapolation number differences. These differences contradict those predicted by target theory. The implications of these findings are also discussed in terms of energy absorption per cell and per chromosome. (auth)

22361 SOME TEMPORAL AND GEOGRAPHIC RELATIONS OF SNAIL RESPONSE TO VERY WEAK γ RADIATION. Brown, Frank A. Jr.; Webb, H. M. (Northwestern Univ., Evanston, Ill.). Physiol. Zool., 41: 385-400(Oct. 1968).

The effect of ^{137}Cs γ irradiation on the turning tendency of mud snails, Nassarius obsoletus was determined in an unvarying symmetrical field of illumination and with initial path in each of the four geographic directions. A ^{137}Cs γ source was presented at right angles to right and to left of the initial snail path. The strength of these horizontal γ fields at the site of the snails was six times the ambient background. With the weak γ source, the snails tended to turn toward the source when they were north and west directed and away from it when south and east directed. The tendency to orient with respect to source direction showed a monthly variation that altered with geographic orientation. Evidence suggested that not only do normally uncontrolled geophysical fluctuations influence the sign and strength of directional responses relative to the γ sources, but also influence differentially the directional responses to oppositely oriented γ fields. The results are interpreted as providing evidence for an intricate, geophysically dependent, time-space organization of these terrestrial organisms, an integrated biological clock and compass complex. Possible bases and significances of this organization are suggested. (BBB)

Vertebrates

Refer also to abstracts 22150, 22161, 22164, 22165, 22177–22179, 22183, 22222, 22227, 22228, 22235, 22237, 22238, 22244, 22245, 22250, 22276, 22277, 22287, 22299, 22321, 22347, and 22439.

22362 (AEC-tr-6944, pp 235-41) BIOLOGICAL EFFECT OF TRITIUM OXIDE. Zhuravlev, V. F.; Bugryshev, P. F.; Istomina, A. G. Translated from pp 182-8 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

1. Intraperitoneal administration of tritium oxide in doses of 1.2 to 2.4 μCi/g to rats and mice caused 100% death of the animals. 2. $LD_{50/30}$ for rats was 1.03 μCi/g and for mice, 0.34 μCi/g. 3. Intraperitoneally injected tritium oxide in rats caused sharp changes in the blood system, as manifested in a decrease in erythrocyte, leukocyte, thrombocyte and reticulocyte counts. Qualitative changes in blood cells also were observed. 4. The administration of tritium oxide produced a persistent depression of the synthetic function of the liver. 5. Owing to the effect of tritium oxide, rats received the bulk of the total tissue dose within the first two weeks. (tr-auth)

22363 (AEC-tr-6944, pp 242-50) BIOLOGICAL EFFECT OF TRITIUM OXIDE WHEN CHRONICALLY RECEIVED BY THE ORGANISM. Zhuravlev, V. F. Translated from pp 188-96 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

1. Prolonged administration of tritium oxide to rats in doses of 0.04, 0.01 and 0.005 μCi/g daily produces the onset of the chronic form of radiation sickness. The degree of severity of this sickness is directly proportional to the total activity of the isotope administered. 2. The chronic effect of tritium oxide in the animals results in depression of hematopoiesis as manifested in a decrease in the erythrocyte, leukocyte, reticulocyte and thrombocyte counts. Toward the end of the second month the rats receiving daily doses of tritium oxide amounting to 0.04 and 0.01 μCi/g begin to display changes in the qualitative blood indicators as well (cytolysis, fragmentosis, vacuolization). 3. Chronic administration of tritium oxide to the organism causes a distinct decrease in the synthetic function of the rat liver. 4. Fractional administration of the isotope is more readily tolerated by animals than single-dose administration of the same amount of isotope. (tr-auth)

22364 (AEC-tr-6944, pp 258-68) EFFECT OF VARIOUS DOSES OF TRITIUM OXIDE ON THE ESTRUAL CYCLE IN THE RAT FEMALES. Lyaginskaya, A. M. Translated from pp 202-11 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effects of tritium oxide on the estrous cycle in rats was studied. Sexually mature females were divided into three groups: one group received a single dose of tritium oxide of 0.3 μCi/g, the second 0.08 μCi/g, and the third were controls. Vaginal smears were made daily at first and then every month for a year. After six to twelve months the rats were mated with normal males. In treated females the estrous cycle changed in frequency and duration of the different stages. Both the proportion of females with normal cycles and the mean number of cycles per female decreased. These effects were proportional to dose and were evident within the first month after treatment. Mammary tumors developed by 12 months. Matings of treated rats resulted in fewer offspring and reduced viability of the offspring produced than in control animals. Eighteen months after treatment none of the effects had been reversed and the rats had become completely sterile. (M.M.B.)

22365 (AEC-tr-6944, pp 269-73) MORPHOLOGICAL CHANGES IN RATS POISONED WITH LARGE DOSES OF TRITIUM OXIDE. Kazbekova, D. A. Translated from pp 211-15 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effects of large doses of tritium oxide were investigated in rats. Sixty male rats were given intraperitoneal doses of 1.0, 1.2, and 2.4 μCi/g of tritium oxide. Pathological examinations were made on 48 lethally poisoned animals. Acute radiation sickness was observed in the first few days following injection of tritium. The pathological changes in the organs and tissues are described. (M.M.B.)

22366 (AEC-tr-6944, pp 274-80) CHANGES IN THE EXCRETION OF DESOXYCYTIDINE IN RATS POISONED WITH TRITIUM OXIDE. Zhuravlev, V. F.; Tereshchenko, O. Ya.

Translated from pp 215-21 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The excretion of deoxycytidine was studied in rats as an indicator of radiation injuries from internal tritium oxide. The animals were kept in metabolic cages (two rats per cage). The urine was collected 3 to 5 days prior to the poisoning and subsequently daily for 30 days after the poisoning. Analysis of deoxycytidine in the urine was modified as follows: Fractionation of urine with the aid of an ion-exchange resin was carried out by successively shaking urine, water and an eluating solution of ammonia together with the resin in a modified column. Otherwise the procedure was standard. In most of the experiments the stage of chromatographic separation of deoxycytidine on paper was omitted. Tritium oxide administered intraperitoneally to rats in a dose of 0.3 μCi/g causes the onset of radiation sickness. The effect of tritium oxide on the animals is such that distinct changes in the blood system develop, as characterized by a decrease in erythrocyte and lymphocyte counts and sharp fluctuations in the neutrophil count. On the second week following poisoning the experimental rats displayed a decrease in deoxycytidine excretion below the original level. (M.M.B.)

22367 (AEC-tr-6944, pp 281-7) NATURE OF CHANGES IN CERTAIN FUNCTIONS OF THE ORGANISM ON CHRONIC POISONING WITH ^{210}Po. Moroz, B. B.; Bezin, G. I.; Vasil'evskaya, V. V.; Grozdov, S. P.; Lebedev, B. I.; Ponmar'kov, V. I.; Fedorovskii, L. L.; Fedotov, V. P. Translated from pp 221-7 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The mechanism of the processes occurring in the course of the radiation poisoning of dogs due to the subcutaneous injection of doses of ^{210}Po of 0.003 μCi/kg body weight was investigated. The initial symptoms of radiation sickness were observed approximately after a month from the date of injection of the radioactive substance. After three months a distinct picture of chronic radiation sickness had developed. Death of the animals occurred after 128 to 310 days. This investigation confirmed the findings of other authors on the selective impairment of erythropoiesis and development of anemia in chronic poisoning with polonium. After a month from the date of the poisoning, a regular decrease in the thrombocyte count had been observed; subsequently this decrease steadily progressed and by the fourth month it was marked by acceleration in the erythrocyte sedimentation reaction. The fact that polonium spread to all the organs and tissues resulted in a constant local α irradiation of these organs and tissues, was apparently a major factor in the genesis of the resultant disorders. During the first month following the administration of polonium there occurred an intense build-up of tissue dose of radiation in the organs. The maximum absorbed-dose levels were observed in the kidneys and liver. A major feature of the trophic disorders developed on chronic poisoning with polonium was the multiplicity of the mechanisms conditioning the development of these disorders, the changes in the nervous and endocrine systems, the direct effect of the α-emitter on the tissues, the metabolic disorders, the manifestations of toxicosis and infection, and hemodynamic disorders and hypoxia are the principal causes each of which in itself may result in trophic changes. But among these causes we must isolate as the leading one the impairment of the neuroendocrine apparatus and the constant local irradiation; in the presence of low doses the significance of the former was clearly greater. (tr-auth)

22368 (AEC-tr-6944, pp 288-99) MECHANISM OF DISTURBANCES IN THE BILIGENIC FUNCTION OF THE LIVER IN THE PRESENCE OF RADIATION SICKNESS CAUSED BY INCORPORATED ^{210}Po AND γ-RADIATION. Poluboyarinova, Z. I.; Fedorovskii, L. L. Translated from pp 227-35 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The biliary clearance method was utilized to investigate the exocrine function of the liver after injury by ^{210}Po and γ-radiation. Thirteen dogs with gallbladder fistula and ligated common bile duct were fed with a standard diet and subjected to experiments 16 to 18 hours following the feeding. The concentration of plasma substances was analyzed in samples of venous blood collected midway during the period of bile collection which lasted from 10 to 30 min. Filtration processes were evaluated with the aid of inulin (by the Harrison method in the modification of N. I. Ivanov) and water; secretory processes were investigated by means of endogenous bilirubin (by the Van den Berg method) and exogenous processes, by administering iododiotrast (by the White and Ralph method) with constant intravenous infusion. In addition, the content of bile acids in the bile was determined by the Schire and Kupi method. On establishing a biligenic function background for the liver, nine dogs were subcutaneously injected with ^{210}Po at the rate of 0.05 μCi/kg and two dogs were γ-irradiated with ^{60}Co by means of an experimental EGO-2 setup in a dose of 300 R. The animals developed acute radiation sickness and died after 12 to 30 days. Analysis of the total absorbed tissue dose in the liver tissue of the dogs showed that in the animals poisoned with ^{210}Po the tissue dose over 12 days reached 2000 rad; over 20 days, 3000 rad; and over 30 days, 4200 rad. The earliest sign of pathological biligenesis was the inhibition of secretion, which was observed as soon as 24 hours from the moment of administration of ^{210}Po. While filtration processes did not change or somewhat increased at the climax of radiation sickness, active secretion of the liver remained lowered. The filtration varied depending on the form of the radiation sickness: it was intensified in the animals with a more acute course of the sickness and retarded in the dogs with a longer time of survival. The overall amount of bile secreted in the dogs did not change markedly. This was due to the triggering of compensatory mechanisms such as the reabsorption of water. The hormonal (ACTH and pituitrin) effect on the regulation of the processes of secretion and filtration changes markedly in the presence of radiation sickness. Comparative analysis of disturbances in the filtration-secretion processes in the liver of animals poisoned with ^{210}Po and γ-radiation indicates that the injurious effect was faster and greater in the case of external irradiation. (tr-auth)

22369 (AEC-tr-6944, pp 300-8) RESPONSE OF HYPOTHALAMO-PITUITARY SYSTEM TO THE ADMINISTRATION OF ^{210}Po AND ^{90}Sr. Voitkevich, A. A.; Ovchinnikova, G. A. Translated from pp 236-42 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The changes occurring in the principal regions of the neurosecretory system on irradiation with ^{210}Po and ^{90}Sr and the possible differences in the effect of these two isotopes were studied. In 60 male rats acute radiation sickness was induced with subcutaneously injected single doses of ^{210}Po (0.1 μCi/kg) and ^{90}Sr (7 μCi/kg). After 6 and 24 hours and after 2, 7, 9, 11, and 14 days, the animals were decapitated. The effect of the isotopes was assessed on the basis of histoautoradiographic findings, histochemical analysis of neurosecretion with the aid of the hemalum-phloxin Bargmann test and paraldehyde-fuchsin Gomori test combined with the Helmi stain test. The findings showed that the changes induced by ^{210}Po and ^{90}Sr in the microscopic picture of the hypothalamic-pituitary system were not the same but apparently reflected the specific nature of the effect of each of these two elements, e.g., the readiness of polonium to form complex compounds with proteins. It is known that the neurosecretory material also is a complex compound, which includes albumin components. This fact accounted for the selectivity of the build-up of polonium in precisely the sites in which formation and, particularly, accumulation of neurosecretory material occurred. This was also characteristic of the anterior lobe of the pituitary, whose basophilic cells formed hormonal principles of an albumin nature. On entering a neurosecretory cell and taking part in its biosynthesis, polonium apparently produced a stimulant effect on the formation of secretion; hence, Gomori-positive granules were detected in the hypothalamic-pituitary system during the first nine days of experiment. The response of neurosecretory cells to strontium was apparently mediated by other processes specific for strontium. (tr-auth)

22370 (AEC-tr-6944, pp 309-15) HISTOCHEMICAL CHANGES IN THE THYROID GLAND OF RATS POISONED WITH ^{210}Po. Tkachev, A. V. Translated from pp 242-7 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

This work is a continuation of the investigation of the morphophysiology of the thyroid gland in ^{210}Po-induced radiation sickness, and it is intended to elucidate certain attendant histochemical changes in the tissue of the thyroid gland. Radiation sickness was induced in 30 male rats with a single subcutaneous dose of ^{210}Po (0.1 μCi/kg). During the development of radiation sickness the animals were investigated 6 hours, and 1, 3, 7, 9, 11 and 14 days after poisoning. Methods included histoautoradiographic analysis, the Bakchus analysis for ascorbic acid and the McManus polysaccharide analysis in sections of the thyroid gland, as well as measurement of cell height and nuclear diameter in the thyroid epithelium. A relationship was established between the amount of ^{210}Po in the thyroid gland and the structural changes in this gland. During the stage when the ^{210}Po content of the thyroid gland reached its maximum, hypoplasia of the thyroid parenchyma was observed. When the ^{210}Po content decreased the thyroid gland acquired a nearly normal microstructure. The amount of ascorbic acid in the thyroid gland was unaffected by acute poisoning with ^{210}Po. The amount of polysaccharides in the colloid decreased at the onset of acute radiation sickness but subsequently increased as the disease reached its climax and then decreased in the last few days prior to the death of animals. (tr-auth)

22371 (AEC-tr-6944, pp 316-23) CENTRAL NERVOUS SYSTEM IN DOGS POISONED WITH ^{210}Po. Lebedev, B. I.

Translated from pp 247-53 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The central nervous system of the dog was investigated in acute and in chronic radiation sickness. The acute radiation sickness was induced by polonium on its subcutaneous injection in the amount of 0.05 μCi/g. This resulted in the death of every animal within two to four weeks following the administration of the isotope. On subcutaneous injection of polonium in the amount of 0.0025 μCi/g death of the dogs occurred after six to ten months. In the experiment killed and dead animals were employed. Pieces of every region of the brain were encapsulated in paraffin or sectioned with a freezing microtome. The conventional neurohistological methods of staining and impregnation were employed. The picture of injury to the central nervous system was fairly similar in both acute and chronic radiation sickness induced by ^{210}Po. The histopathology of the brains in polonium poisoned dogs is described. (M.M.B.)

22372 (AEC-tr-6944, pp 324-32) SULFADIMEZINE METABOLISM IN THE ORGANISM OF WHITE RATS POISONED WITH ^{210}Po. Dunaev, V. V. Translated from pp 253-60 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

This investigation deals with the metabolism of sulfadimezine (2-paraaminobenzenesulfamido-4, 6-dimethylpyridine) in an organism poisoned with ^{210}Po. Radiation sickness was produced in 150 male rats with a single subcutaneous dose of ^{210}Po in the amount of 0.03 μCi/kg, which resulted in death after 13 to 40 days. The pattern of the absorption, distribution and transformation of sulfadimezine in the poisoned animals was investigated on the 1st, 5th, 10th, 15th and 25th days of disease after 1, 3, 6, 12, and 24 hours following the single-dose intragastric administration of the drug in the amount of 100 mg per 100 g of body weight. The blood, kidneys, liver, lungs, spleen, brain and upper division of the gastrointestinal tract were analyzed. Analysis of free and bound forms of sulfadimezine was carried out by the method of A. M. Timofeeva. The findings were processed by the method of variational statistics. The resorption of sulfadimerazine from the upper region of the digestive tract was not markedly affected by the presence of radiation sickness. The development of radiation sickness was accompanied by a sharp build-up and rapid disappearance of the sulfanilamide from the organs during the 1st, 5th and 10th days of the sickness, followed by a slow increase in the maximum concentration of the drug during the terminal stage of the sickness. The administration of ^{210}Po to the organism reduced the proportion of bound sulfadimezine in every organ investigated. (M.M.B.)

22373 (AEC-tr-6944, pp 333-9) FEATURES OF THE BIOLOGICAL EFFECT OF CERTAIN RADIOACTIVE ISOTOPES REPRESENTING ANALOGS OF STABLE BIOELEMENTS. Kurlyandskaya, E. B. Translated from pp 260-6 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

A comparison was made of the effects of the administration of ^{60}Co, ^{59}Fe, and ^{65}Zn on erythrocyte and lymphocyte counts and hemoglobin content of animal blood. It was found that the effects of the isotopes differed from each other and from the effects of similar doses of external irradiation. (M.M.B.)

22374 (AEC-tr-6944, pp 345-9) CHRONIC EFFECT OF RADIOACTIVE SULFUR. Oganesyan, N. M. Translated from pp 270-4 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effects of chronically administered small doses of ^{35}S were studied in rats. Daily peroral doses (13.5 μCi per 250 to 300 g rat) were administered for three months. The radioactivity level in the organs and tissues of the rats increased during the first three months and beginning with the third month reached an equilibrium in all the organs, except in the muscles and brain where it continued to increase. Thus, radiometric analysis did not reveal any selective build-up of ^{35}S in the individual organs. The chronic effects of ^{35}S on hematopoiesis and histopathology were investigated. Rats in group 1 received perorally ^{35}S in the form of sodium sulfate, in daily doses of 0.2 μCi/kg, which is 10 times the maximum permissible concentration for ^{35}S recommended by the International Committee for Radiological Protection (1959). Rats in group 2 received daily doses of 2 μCi/kg, and group 3 received stable isotope of sulfur in the same amounts and in the form of the same chemical compound as the rats in group 2. Observations of the animals lasted seven months. The most marked changes occurred in rats of group 2. The absorbed dose produced in the body and individual organs of the rats in this group ($\sim$15 to 18 rad per year) was only 3 to 4 times as high as the maximum permissible dose for the most radiosensitive organs (the gonads), but nevertheless the animals in this group displayed hematological and pathomorphological changes indicating the presence of radiation damage. Considering that distinct functional and morphological changes occurred only in animals receiving doses 100 times as high as the maximum permissible concentration, while in animals receiving doses 10 times as high as the maximum permissible concentration these changes were insignificant, it may be assumed that a safety margin of 10 should suffice to prevent radiation injuries. Hence, the current recommended maximum permissible concentration of ^{35}S in water in the form of sodium sulfate may be considered biologically substantiated. (tr-auth)

22375 (AEC-tr-6944, pp 350-8) BIOLOGICAL EFFECT OF COMBINED EXPOSURE TO ^{131}I AND NOISE (FUNCTIONAL STATE OF THE THYROID GLAND). Mukhamedov, T. Translated from pp 274-81 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effects of chronically administered ^{131}I, alone and with noise, on the function of the thyroid gland were studied. Dogs were given daily subcutaneous injections of ^{131}I (4 to 5 μCi/kg) for eight months. Some were additionally exposed to three hours of 100 to 105 db noise each day. Controls were given noise alone or neither noise nor ^{131}I. Albumin-bound iodine and permeability of skin capillaries were used as indicators of thyroid gland function. Chronic administration of ^{131}I to the organism caused multistage changes in functional activity of the thyroid gland. A stage of enhancement of the thyroid gland function was followed by a stage of stabilization and finally by a stage of depression. On exposure to the combined effect of ^{131}I and noise these multistage changes became more distinct, but the stage of depression started later. Morphological examination (at a late period) of the thyroid gland revealed degenerative changes that were particularly distinct in the animals subjected to both ^{131}I and noise. The changes in the permeability of skin capillaries in dogs chronically receiving ^{131}I alone as well as in dogs exposed to both ^{131}I and noise were of a multistage nature. (M.M.B.)

22376 (AEC-tr-6944, pp 359-74) BIOLOGICAL EFFECT OF NITRATE ^{232}Th. Kendysh, I. N.; Lebedeva, G. A. Translated from pp 281-93 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

An investigation was made of the biological effects of thorium-232 nitrate. A solution (pH = 3) was intratracheally administered in a single dose (10 mg of thorium metal per kg body weight), and also perorally and intraperitoneally administered in a single dose (100 mg/kg). Chronic poisoning with thorium was carried out once weekly in doses of 100 mg/kg until a total dose of 1000 mg/kg was reached. The experiment was performed on 300 white male rats weighing 200-250 g and 20 rabbits weighing 2-2.5 kg. The rats were poisoned by all the methods named above, while the rabbits received single peroral and intraperitoneal doses as well as chronic peroral doses. The tests employed included: observation of the clinical course of poisoning; investigation of the composition of peripheral blood, phagocytic function of the reticuloendothelial system, functional state of the liver; and morphological examination of the lungs, liver and spleen. Changes in the composition of peripheral blood of the rats were analyzed by standard hematological methods. Changes in the blood composition were early anemia and acute reticulopenia in combination with early increase in thrombocyte count which subsequently dropped to its original level or even below that level. At a later period there developed distinct leukocytosis with absolute and relative neutrophilia and moderate lymphopenia. The hematological changes were most distinct on intratracheal administration of thorium. From the first days following the incorporation of thorium there developed an extensive blocking of the phagocytic activity of the reticuloendothelial system, accompanied by a decrease in the weight of the liver and spleen and in their phagocytic capacity with respect to colloidal gold. The degree of this blocking was the highest following intratracheal administration of thorium, but recovery of normal phagocytic activity occurred earlier than for other pathways of administration. Within the first month the elimination of ^{131}I-tagged rose bengale from the rabbit liver and the rate of hepatic blood flow decreased. These changes did not explicitly tend toward normalization during the 12 months of experiment. Morphological examination made it possible to establish that thorium caused not only certain general disturbances (dilatation of vascular walls, focal hyperemia and occasional mild dystrophy of the liver) but also fairly extensive local injury of the tissues with the formation of distinctive granuloma-like cells proliferations; this was due to its physico-chemical properties and the pattern of its distribution in the organism. The changes in the internal organs occurred as early as within the first month following the administration of the element, and they largely depend on the pathway of its administration: the most significant disorders were observed following intratracheal and intraperitoneal administration. The findings suggest that, for the period of investigation (12 months), the biological effect of ^{232}Th was due to its chemical rather than radioactive properties. (tr-auth)

22377 (AEC-tr-6944, pp 375-83) NEUROENDOCRINE DISORDERS IN THE ORGANISM OF DOGS CHRONICALLY RECEIVING ^{90}Sr. Burykina, L. N.; Rynkova, N. N.; Titova, L. A.; Trusova, N. E.; Chusova, V. N. Translated from pp 294-301 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The functional state of the sex glands and adrenals in dogs chronically poisoned with ^{90}Sr was investigated. The radioactive isotope was given to experimental animals perorally in food daily (except on days off) at the rate of 0.2, 0.02, and 0.002 μCi/kg daily for 3 to 3.5 years. Twenty experimental and 10 control animals were kept under observation. At the beginning of experiment the weight of the dogs ranged from 16 to 20 kg and their age, from 1.5 to 5 years. Along with investigation of the activity of endocrine glands, the functional state of the cardiovascular system, hematopoiesis, liver and kidneys were investigated. The metabolism of estrogens in the experimental and control females was investigated during the interestrual periods and pregnandiol analysis was made. The dynamics of spermatogenesis was investigated once every one or two months during and after the administration of ^{90}Sr. The volume of ejaculate, the sperm count, and the sperm activity were estimated, and the ejaculate was analyzed for the presence of atypical forms. Biological activity of the androgens was analyzed on castrated male rats. The functional state of the adrenal cortex was evaluated according to the content of neutral 17-ketosteroids and 17-oxycorticosteroids in the daily urine of the dogs, with the aid of colorimetric procedures. On chronic administration of various ^{90}Sr dose levels (from 0.2 to 0.002 μCi/kg daily) per os to dogs, multistage changes were observed in the functional state of the sex glands and adrenals. During the initial period of the effect of ^{90}Sr (when the absorbed skeleton dose reaches 5 to 15 rad) the functional activity of endocrine glands was observed to increase. Once the absorbed skeleton dose reached 50 to 100 rad, spermatogenesis in the males became depressed and the fractional composition of sex hormones in females had changed. Depression of the adrenocorticoid function was observed once the absorbed skeleton doses in the dogs reached approximately 150 to 250 rad. The smaller the ^{90}Sr doses received by the experimental animals the later was the period of time during which the disturbances occurred. At a late stage of observation (2.5 to 3 years after the beginning of experiment) depression of biological activity of androgens was observed in the experimental dogs. Functional tests with ACTH loading revealed that the mechanisms of disturbances in the adrenal functions differed in each group of experimental animals. (tr-auth)

22378 (AEC-tr-6944, pp 384-99) DISTURBANCES IN THE HEPATIC AND RENAL FUNCTION OF DOGS IN LATE STAGES OF CHRONIC POISONING WITH ^{90}Sr. Burykina, L. N.; Nevskaya, A. I.; Ovdienko, N. I.; Tutochkina, L. T. Translated from pp 301-13 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

An investigation was made of the functional state of the liver and kidneys in dogs chronically poisoned with ^{90}Sr (0.2 to 0.0002 μCi/kg daily) for 3 to 3.5 years. During and after chronic administration of ^{90}Sr the state of the glycogenproducing and bile-secreting function of the liver was investigated. This was accompanied by analyses of the albumin composition of blood serum: the total albumin concentration in the blood serum, the relative content of albumin fractions (by the paper electrophoresis method) and the level of blood serum mucoids. The cholinesterase activity of blood serum was also investigated. The blood sugar level was determined both in fasting animals and in animals under a glucose loading. The glucose (in 13% solution) was introduced via a stomach probe at the rate of 2 g per kg body weight of animal. The blood for analysis was collected before loading and once every 30 minutes after loading for 2.3 to 3 hours. The functional state of the liver was also analyzed with the aid of ^{131}I-tagged rose bengale. Radioactivity curves for liver were recorded in a DSU-60 device equipped with an automatic recording ampere-voltmeter. The functional state of the kidneys was investigated by the radioisotope method on using ^{131}I-tagged cardiotrast. In the late stages of chronic poisoning with small doses of ^{90}Sr (0.2, 0.02 and 0.002 μCi/kg daily in food for 3 to 3.5 years) and following the cessation of poisoning the experimental animals displayed changes in carbohydrate and protein metabolism as well as in acetylcholine metabolism. The changes in carbohydrate metabolism were characterized by atypical sugar curves and high levels of hyperglycemic and postglycemic coefficients. This was more distinct in animals receiving 0.02 μCi/kg. In the experimental animals a general tendency toward a decrease in serum mucoids was observed by comparison with control animals of corresponding age. A lower albumins/globulins ratio was detected in dogs receiving 0.02 μCi/kg, due to the higher relative content of β- and γ-globulins. A rise in cholinesterase activity of the blood serum in the experimental animals on administration of higher doses of ^{90}Sr pointed to disturbances in liver function. The functional state of the liver and kidneys revealed marked changes in the secretory and excretory function of these organs only in the experimental animals receiving 0.02 μCi/kg. (tr-auth)

22379 (AEC-tr-6944, pp 400-9) INVESTIGATION AND COMPARATIVE ASSESSMENT OF THE CHRONIC EFFECT OF ^{90}Sr AND ^{144}Ce. Zapol'skaya, N. A.; Fedorova, A. V.; Lavrent'ev, L. N.; Tsygankova, Yu. I.; Yakovleva, N. G.; Grigoryan, Kh. V.; Mirzoyan, A. A. Translated from pp 400-9 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

It is known that the critical organ for ^{90}Sr bony tissue and for ^{144}Ce the gastrointestinal tract. A comparison was made of the biological effects of these two isotopes in rats. Some animals received daily doses of ^{144}Ce in equilibrium with ^{144}Pr of 1.6 or 0.16 μCi for 120 days. Others received 8×10^{-2} or 8×10^{-3} μCi of ^{90}Sr in equilibrium with ^{90}Y. Administration was by stomach probe. Determinations were made of blood cell numbers, cholinesterase activity in erythrocytes, alkaline phosphatase activity in serum, histamine and residual nitrogen in blood, histamine content of the tissues in various organs and pathology of the gastrointestinal tract. Absorbed doses were determined by radiometric analysis. The experimental findings indicated that while the changes in the presence of ^{90}Sr and ^{144}Ce displayed the same general orientation, they differed markedly in intensity and sequence of development. The changes in certain biochemical indicators characterizing the general response of the animal were more distinct on poisoning with ^{90}Sr than on poisoning with ^{144}Ce. (M.M.B.)

22380 (AEC-tr-6944, pp 421-5) COMPARATIVE EVALUATION OF THE EFFECT OF VARIOUS ISOTOPES ON THE FUNCTIONAL ACTIVITY OF THE ADRENAL CORTEX. Smorodintseva, G. I. Translated from pp 331-4 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

A comparative assessment was made of the function of the adrenal cortex in rats chronically poisoned with ^{144}Ce and ^{90}Sr. Animals received peroral doses of either 1.6 μCi of ^{144}Ce (per 172 ± 7 g rat) or 8×10^{-3} μCi of ^{90}Sr daily. These amounts produced roughly equal skeleton doses but different gastrointestinal tract doses. The weight of the adrenals and thyroid glands and the content of ascorbic acid and cholesterol in the adrenal tissue were measured on the 1st, 5th, 10th, 30th, 60th, and 90th day of chronic poisoning. The rats treated with ^{90}Sr responded with an early increase in adrenal cortical activity with subsequent reduction to normal followed by another increase in activity. The administration of ^{144}Ce did not result in an early increase in adrenocortical activity but there was a later decrease in ascorbic acid and cholesterol content. (M.M.B.)

22381 (AEC-tr-6944, pp 434-40) EFFECT OF PROLONGED ADMINISTRATION OF ^{144}Ce AND ^{90}Sr ON CERTAIN ASPECTS OF LIPID METABOLISM IN THE ORGANISM OF THE RAT. Shagoyan, A. G.; Fedorova, A. V. Translated from pp 340-6 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effects of internal ^{144}Cs and ^{90}Sr on the lipid fractions in the blood, liver, and cerebral tissues of rats were studied. A group of animals received ^{144}C (as cerium chloride in daily doses of 1.6 μCi per rat into the gastrointestinal tract. Another group received ^{90}Sr (as strontium nitrate) in daily doses of 8×10^{-2} μCi per rat. The effect of ^{144}Ce was characterized by earlier changes in the concentration of lipid fractions and more rapid normalization. The effect of ^{90}Sr was characterized by more tardy but also more persistent changes in the lipids of the blood and other organs. (M.M.B.)

22382 (AEC-tr-6944, pp 441-52) COMBINED EFFECT OF ^{90}Sr, ^{144}Ce AND ^{239}Pu ON THE RAT ORGANISM (REPORT 1). Moskalev, Yu. I.; Buldakov, L. A.; Koshurnikova, N. A.; Nifatov, A. P.; Reshetov, G. N. Translated from pp 346-56 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The biological effect of two isotopes with the same and different patterns of distribution in the organism and with the same and different microgeometry of distribution in the tissues was investigated. Inclusive of the controls (115 males and 112 females), 1540 rats were used. Histological tissue analyses of 1474 rats were performed. The experiments showed that the combined administration of two isotopes (strontium with plutonium and cerium with plutonium) resulted in the same kinetics of metabolism of each emitter in the principal build-up organs as separate administration. Hence, we were able to group together the findings on the kinetics of metabolism of each isotope regardless of whether it was administered separately or together with another isotope. The elimination of strontium, cerium and plutonium from the critical organs obeys an exponential law during the period from the 16th until the 918th day of observation, regardless of whether the isotopes were administered singly or in a combination. On combined administration of a pair of isotopes with the same or different nature of distribution in the organism, most of the resulting radiation injuries not only are additive (cerium with plutonium) but also manifest themselves earlier (in most cases for strontium with cerium or strontium with plutonium) given the same or even smaller absorbed radiation doses. The RBE of plutonium compared with β-emitters differs for different criterions and, moreover, depends on the amounts of isotopes incorporated. (tr-auth)

22383 (AEC-tr-6944, pp 453-62) COMBINED EFFECT OF ^{90}Sr, ^{144}Ce AND ^{239}Pu ON THE RAT ORGANISM (REPORT 2). Moskalev, Yu. N.; Buldakov, L. A.; Koshurnikova, N. A.; Nifatov, A. P.; Reshetov, G. N. Translated from pp 356-65 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The long-term combined effects of ^{144}Ce, ^{239}Pu, and ^{90}Sr on rats are described. Separate and combined administration of ^{90}Sr, ^{144}Ce and ^{239}Pu increases the frequency of tumors in the experimental rats. Combined administration of pairs of isotopes, compared with their separate administration, magnifies the osteosarcomogenic and leukomogenic effect when strontium is administered together with cerium or with plutonium, causes these effects to be additive when cerium is administered together with plutonium, and magnifies the cirrhosogenic effect when cerium is administered together with plutonium. (M.M.B.)

22384 (AEC-tr-6944, pp 463-69) SOME FINDINGS ON THE DEVELOPMENT OF CIRRHOSIS OF THE LIVER UNDER THE INFLUENCE OF RADIOACTIVE CERIUM. Lebedeva, G. A. Translated from pp 365-71 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

A detailed investigation of cirrhosis of the liver and of the morphological changes preceding its development was made. One hundred and fifty rats were injected intraperitoneally with ^{144}Ce in doses of 1.5, 1.0 and 0.5 μCi/g. The livers of the dead and killed animals were analyzed over a period of from the 1st to the 400th day of the experiment. Materials were fixed in 10 percent formalin solution and encapsulated in paraffin. The sections were stained by the Van Gieson hematoxylin-eosin method and impregnated with silver by the Foot method. Frozen sections were stained with sudan III. Distribution of the radioactive isotope in the liver was analyzed by the autoradiographic method and by exposing sections on photographic film and plates of the MR type. During development of cirrhosis of the liver induced by radioactive cerium the proliferation of connective tissue was usually preceded by dystrophic and necrobiotic changes as well as by disturbances of the regenerative process in the parenchyma of the organ. The development of cirrhotic changes was oriented either toward the onset of annular cirrhosis or toward a more diffuse proliferation of connective-tissue structures. The pattern of growth of connective tissue in the liver largely depended on the features of the course of the pathological process in its parenchyma. (M.M.B.)

22385 (AEC-tr-6944, pp 470-83) LONG-TERM CONSEQUENCES OF ^{147}Pm POISONING. Strel'tsova, V. N. Translated from pp 371-83 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The blastomogenic effectiveness of ^{147}Pm in doses ranging from the maximum permissible to 1.0 μCi/g was investigated. Rats were given single intraperitoneal doses of ^{147}Pm of 0.001, 0.01, 0.1, 0.55 or 1.1 μCi/g. Those surviving for more than 200 days were examined pathologically. The minimum doses of this isotope conditioning the occurrence of osteosarcoma and leukosis was 0.1 μCi/g which created in the bony and blood-forming tissues doses of the order of 500 to 700 and 250 rad, respectively. The attendant occurrence of nonspecific pathological processes (rachitis, inflammation) resulted in the generalization of these processes in terms of both the frequency of occurrence and the severity of their course. (M.M.B.)

22386 (AEC-tr-6944, pp 484-92) EFFECT OF ADDITIONAL PATHOLOGICAL FACTORS ON THE LONG-TERM CONSEQUENCES OF ^{239}Pu POISONING. Lemberg, V. K.; Koshurnikova, N. A.; Nifatov, A. P.; Bukhtoyarova, Z. M.; Kudasheva, N. P. Translated from pp 383-91 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

This investigation presents the findings on experiments organized with the object of elucidating the effect of additional pathological factors on the long-term consequences of poisoning with ^{239}Pu. The isotope was administered in single doses of 0.63×10^{-3} and 2×10^{-3} μCi/g in the form of its nitrate salt (the pH of the solution was 2.0) to Wistar rats. On administration of 0.63×10^{-3} μCi/g of plutonium an ionization dose of 324–440 rad accumulated by the 550th day in the rat skeleton. After 2×10^{-3} μCi/g of plutonium the ionization dose in the liver on the 500th day reached about 200 rad. Following the injection of plutonium in the dose of $0.63 \cdot 10^{-3}$ μcurie/g repeated aseptic inflammation was produced by introducing 0.1 ml of turpentine under the skin of the hip once every two weeks during three months. Three cycles of administration of isotopes at intervals of three months between the cycles were carried out; in the poisoned animals the first cycle was commenced on the 15th day following the administration of plutonium. Multiple repeated bloodlettings were carried out once a week in the volume of one percent of body weight. Three cycles of eight bloodlettings each were carried out at intervals of 2–3 months between the cycles; in the poisoned rats bloodletting was commenced on the 30th day following the administration of plutonium. Repeated mechanical trauma was applied to the bones once every 2 to 2.5 months; triple fractures of the femoral bones (under ether anesthesia) were carried out without subsequent immobilization of the animals; in the poisoned animals the trauma was first applied on the 30th day following the administration of plutonium. In part of the animals the cellular composition of peripheral blood was analyzed once every month. Following quadruple administration of plutonium in the dose of 2×10^{-3} μCi/g at monthly intervals, the rats were intramuscularly injected with carbon tetrachloride in the amount of 0.5 ml per 100 g body weight. In the animals poisoned with $0 \times 63 \cdot 10^{-3}$ μCi/g of plutonium the cell composition of peripheral blood throughout their life did not markedly differ from same in controls, and neither did the response of peripheral blood to repeated bloodlettings. On the other hand, repeated aseptic inflammation caused a gradually increasing depression of the leukocytic response in the plutonium-poisoned animals by contrast with the animals which received turpentine alone. Repeated aseptic inflammations produced, up to a point, an inhibiting effect on the development of skeletal tumors in plutonium-poisoned rats, whereas repeated bloodlettings and mechanical injury of bones contributed to this development in the rats. Repeated blood loss and multiple mechanical traumas of the skeleton had cocarcinogenic effects with radioactive substances not only in carcinogenesis associated with the direct effect of ionizing radiation on the tissue (osteosarcomas, leukoses) but also in the formation of tumors owing to hormonal dysfunction (adrenal tumors). (tr-auth)

22387 (AEC-tr-6944, pp 493-502) EFFECT OF TRITIUM OXIDE ON THE POSTNATAL DEVELOPMENT OF RAT OFFSPRING POISONED AT VARIOUS PERIODS DURING ANTENATAL LIFE. Lyaginskaya, A. M.; Zhukova, I. V. Translated from pp 391-9 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The administration of 0.3 μCi/g of tritium oxide to rats at various periods of pregnancy caused a marked lag in the growth and development of their offspring in the postnatal period. A high death rate of offspring was observed in the postnatal period (as much as 65%) regardless of the state of intrauterine development during which the poisoning was applied. Poisoning during the pre-implantation period caused the highest proportion of intrauterine deaths of the embryos. Poisoning with tritium oxide during the fetal period caused a somewhat higher proportion of postnatal deaths of the offspring than poisoning during other periods of prenatal development. No deformities in the development of offspring were observed. (tr-auth)

22388 (AEC-tr-6944, pp 503-13) EFFECT OF TRITIUM OXIDE ON THE FERTILITY OF MALES. Zhuravlev, V. F.; Lyaginskaya, A. M. Translated from pp 399-407 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The administration of tritium oxide in the doses of 0.3 and 0.08 μCi/g to rats produced a sterilizing effect on males. This effect depends on the dose size and is expressed in: (a) decrease in the mating ability of the males; (b) decrease in the numbers of offspring in litters produced by mating the males with intact females; (c) frequent deaths of fetuses and a high proportion of stillbirths; (d) change in the weight of testes. Tritium oxide administered to rats in the dose of 0.08 μCi/g did not produce marked changes in the blood system. The administration of tritium oxide in the dose of 0.3 μCi/g produced marked changes in the blood system as expressed in the decrease in erythrocyte and lymphocyte counts and sharp fluctuations in the neutrophil count. (tr-auth)

22389 (AEC-tr-6944, pp 514-25) DEVELOPMENT OF THE OFFSPRING OF MICE CHRONICALLY POISONED WITH ^{90}Sr. Shvedov, V. L.; Korytnyi, V. S. Translated from pp 408-17 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

Systematic penetration of small amounts of ^{90}Sr into the organism markedly affected the offspring of mice. The reproduction rate of baby mice decreased progressively from the first litter to the sixth litter in proportion to the daily dose of ^{90}Sr administered.

Daily administration of ^{90}Sr doses of 0.35 and 0.035 μCi/g per mouse lead to a distinct decrease in the viability of the suckling young and in the numbers of offspring per litter, and to a disturbance in the normal ratio between the sexes as well. (tr-auth)

22390 (AEC-tr-6944, pp 526-37) EFFECT OF ^{90}Sr ON INTRAUTERINE DEVELOPMENT OF THE FETUS. Lyaginskaya, A. M.; Smirnova, E. I. Translated from pp 417-26 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

^{90}Sr administered to rats in a single intraperitoneal dose of 0.4 μCi/g 10 days prior to first mating caused disturbances in intrauterine development. The processes of cleavage and implantation of the fertilized ovum deviated from the norm and some of the embryos died before or during the implantation. The observed disturbances in the process of placentation and placental development were characterized by changes in the weight and size of the placentas, under-development of the placentas, disorders in mother-placenta blood circulation and death of placentas. During organogenesis certain general growth anomalies arose; they were characterized by underdevelopment of uteri, decrease in the weight and size of fetuses, death of fetuses, which was particularly frequent between the 9th and 15th days of intrauterine development (60%) and decrease in the amount of perifetal waters. The growth anomalies in the fetus that arose during the early stage of organogenesis persisted in the newborn. They were expressed by underdevelopment, edema, and local statis of cutaneous or deep-seated vessels as well as by hemorrhages. The general anomalies observed in the first few days of postnatal life were: asphyctic state, dystrophy (stunted body, thin, folded, relatively immobile and dry skin compactly adhering to the underlying tissues), edemas and pathological manifestations in the vascular system. The most frequent type of anomaly was subcutaneous hematoma (in as many as 40.6% of the third-litter ratlings). The most frequent organic anomalies encountered were anomalies of the heart and bones. Disturbances in heart development were characterized by delays and defects of anlage, decrease in weight and size of heart, change in the weight ratio between heart and body and the occurrence of atypical forms and atypical histological structures. Anomalies in bone development manifested themselves in growth delays, smaller weight of body and skeleton, and retardation (by one or two days) of the processes of calcification, ossification and bone readjustment. The disturbances arising during the ontogenesis of rats were encountered in most cases and were more deep-seated in the offspring of the third litter, i.e., at a late stage of ^{90}Sr poisoning. The observed peculiarities in the development of the offspring of rats poisoned with ^{90}Sr chiefly depended on the state of the mother's organism rather than on the direct effect of the isotopes. (tr-auth)

22391 (AEC-tr-6944, pp 538-47) FEATURES OF THREE GENERATIONS OF OFFSPRING OF ^{90}Sr-POISONED RATS. Novikova, A. P. Translated from pp 426-34 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

An investigation was made on the effects of ^{90}Sr on three successive generations of rats. Strontium-90 was injected intraperitoneally in a single dose of 0.4 μCi/g each to both parents (males and females simultaneously). Twelve days following the administration of the isotope the females were each placed in a separate cage and mated with one male each. After two or three days the males were removed and the females were left alone in their cages until the end of the observation period. The newborn rats were left with the lactating mother for 28 to 30 days, after which they were labeled with identifying marks and separated from the females. To preclude inbreeding the male rats were kept separately from their female siblings and mating was performed rigorously according to the identification markings. The young rats were mated once for each generation (i.e., females of group F_1 were mated with males F_1 and females of group F_2, with males of F_2). The conditions of feeding, mating and separation of the offspring were identical in all the generations. Part of the animals of each generation was used in the experiments while the other part was left in the vivarium under normal conditions until natural death. Macro- and microscopic examination of these animals following their death revealed deviations that are of definite interest to further research into the problem. The investigation made it possible to obtain some findings on the question of spontaneous deviations in adult rats as well as material on the pathomorphological characteristics of the offspring of parents that had been poisoned with ^{90}Sr. The numerical scarcity of the material and its somewhat random nature (the observations were secondary to the solution of other problems) do not substantiate drawing any definite conclusions. Nevertheless, the occurrence of osteosarcomas that are unusual for this species of animals and that moreover occurred in generations that were not carriers of the radioactive isotope, deserve attention per se and the organization of special experiments. (M.M.B.)

22392 (CEA-CONF-1173) EFFECT OF IRRADIATION DOSE ON THE LATENT PERIOD OF RABBIT CATARACTS. Legeay, G.; Haye, C.; Bazin, J. P.; Quechon, H. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 24p. (In French). (CONF-681013-10). Dep.

From 1st European Congress on Radiation Protection and Exhibition on Equipment Using Low Energy and Short Range Radiation Dosimetry, Menton, France.

The eye of the rabbit is particularly suitable for the study of the correlation between the cataractogenic effect of ionizing radiation and the absorbed dose. In order to show this relation four stages of opacification of the crystalline lens were investigated. The rhythm of the ophthalmological examinations was taken into account and the latency time was determined. The experimental data were analyzed by the probit method; symmetrical roles were given to the dose and time factors and analogous hypotheses were made on the fixed dose and fixed time response functions. For the different stages of opacification fixed time 50% doses and fixed dose 50% incidences (50% latency time) were furnished. The experiments were done with γ rays and neutrons and the RBE was determined. (tr-auth)

22393 (EUR-4043) OSTEOMYELOFIBROSIS IN RATS AFTER LETHAL WHOLE-BODY IRRADIATION AND TRANSFUSION OF ALLOGENIC BONE MARROW CELLS. Becker, H.; Cronkite, E. P.; Fliedner, T. M.; Messner, H.; Stodtmeister, R. (Ulm Univ. (West Germany). Zentrum fuer Klinische Grundlagenforschung). May 22, 1968. 172p. (In German). Dep.

The clinical, pathological, anatomical, and histological findings on 468 non-osteomyelofibrotic and 48 osteomyelofibrotic rats after whole-body x irradiation and consequent bone marrow cell transfusion are reported. The importance of the experimental conditions for the formation of a fibrosis was examined. Comparisons were drawn with non-myelofibrotic rats used in the same series of experiments, as well as with the changes observed in osteomyelofibrosis in humans. The possible etiologies for the production of fibrosis in the test animals are discussed on the basis of test models and the findings obtained. The importance of an immunologic interpretation in accordance with an autoimmunization reaction is stressed. The significance of such an interpretation for the comprehension and the classification of certain forms of osteomyelofibrosis in humans is discussed. (93 references) (auth)

22394 (N-68-16107) LIGHT AND ELECTRON MICROSCOPIC STUDY OF PRIMATE (MACACA MULATTA) LIVER AFTER LARGE DOSES OF HIGH-ENERGY (2.3 GeV) PROTONS. Ghidoni, J. J.; Campbell, M. M.; Thomas, H. (Baylor Univ., Houston, Tex. Lab. of Experimental Pathology). [1967]. 22p. (NASA-CR-92688). CFSTI.

Morphological data are presented on a series of experiments in which the livers of seven primates were exposed to high-energy protons which penetrated the whole animal. Data were collected at intervals of 15 minutes, 6, 12, 18, 24, 36, and 48 hours after irradiation with 2.3 BeV protons. The results of the electron microscopic studies performed on the irradiated primate liver at these time intervals are discussed. The progressive increase in hepatic lipid which was first noted at 15 minutes and persisted until 24 hours, after which it leveled off and decreased sharply, is considered a significant finding. Small cytoplasmic clefts, the number of dark cells in the post-irradiation tissue, and mitochondrial alterations are also mentioned. Pictures are presented to illustrate the various findings considered. (STAR)

22395 BIOLOGICAL RESPONSE TO SMALL DISCRETE HIGHLY RADIOACTIVE SOURCES. I. OBSERVATIONS ON GASTROINTESTINAL TRANSIT, HISTOLOGICAL CHANGE, AND TISSUE DEPOSITION IN BEAGLES FED ONE-HALF CURIE $^{238}PuO_2$ FOR 6 MONTHS. Richmond, C. R.; London, J. E.; Wilson, J. S.; Langham, J. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 15: 487-92(1968). (LA-DC-9298).

Biological response to high specific activity particulate nuclear fuels being considered for heat sources in thermoelectric generators may ultimately influence use of such systems in space programs; conventional concepts of radiation dose contribute little to hazard evaluations because of huge energy depositions in very small tissue volumes. Studies have established that nuclear fuel particles are not preferentially retained in the G.I. tract of man because of small size or high density. The effects of high surface doses (~10^8 and ~10^3 RAD/hr for alpha and x rays, respectively) on holdup and histological changes within the G.I. tract are reported. Forty $^{238}PuO_2$ particles were fed weekly for 25 weeks to beagles from an electrically driven carrousel. The average particle (189 μ diameter) contained 0.55 mCi of ^{238}Pu. Whole-body counting was used to determine the presence or absence of particles in the dogs following each weekend nonfeeding period; no evidence for prolonged holdup was found. Although no gross histological changes were observed at sacrifice, some histological changes of unknown significance were detected in the lamina propria. No changes were seen in the epithelium. Deposition in liver, mesenteric lymph node, and spleen was 10^{-10} to 10^{-8} of the fed activity. (auth)

22396 STUDIES ON TIME FACTOR IN RADIOTHERAPY FOR CERVICAL CANCER OF THE UTERUS. PART I. EXPERIMENTAL STUDY. Furuta, Takafumi (Shinshu Univ., Matsumoto, Japan). Shinshu Igaku Zasshi, 16: No. 6, 33-52(Dec. 1967). (In Japanese).

In order to study the time factor in the biological action of radiation, three experiments were performed. Silkworm eggs were telecobalt irradiated and lethality and hatching process were observed. Results revealed that if the overall time was constant, the effect of radiation was lessened by more fractionation and that if the number of fractionations was constant the effect of radiation was lessened by the longer intervals between irradiations. Solid Ehrlich tumor transplants in the thigh muscles of mice were telecobalt irradiated at a total dose of 4800 R during a 24-day period. Results showed that both tumor-reducing and life-prolonging effects were strongest in groups fractionally irradiated at 48 and 72 hour intervals; the effect of daily irradiation was the same as that of every other day irradiation at a single dose reduced by 15%. Mice bearing Ehrlich ascites tumors were whole-body telecobalt irradiated and the change in mitotic index of the ascites cancer cells was studied. Results revealed that at a single radiation dose of 600 R, the mitotic index decreased more and that the period during which the mitosis was inhibited was longer than in a 300 R irradiated group. During recovery, a time of hypermitosis occurred. This phenomenon was observed between 24 and 48 hours after irradiation at 300 R and at 48 hours in the 600 R irradiated mice. In the twice-irradiated cases (single dose of 300 R each time), a periodic rhythm in the mitotic index was observed when the interval between irradiation was 48 or 72 hours. (TSS) (NSA of Japan)

22397 EFFECTS OF RADIATION ON MOUSE EMBRYOS. VI. MORPHOGENESIS OF DIGITAL MALFORMATIONS BY X-IRRADIATION. Takeda, Norio; Mino, Yutaka; Tamaki, Naonori; Fujiki, Yoshishige (Osaka Univ.). Osaka Daigaku Shigaku Zasshi, 13: 211-18(June 1968). (In Japanese).

Embryos of mice were x irradiated at 100 to 350 R doses and digital formation was observed in relation to physiological meronecrosis and dactylus formation. A direct relation was found for radiation dose and ectodactylation and hematoma dactylis but not for polydactylism or syndactylism. It was concluded that x radioinduced ectodactylism was directly caused by destruction of the finger base and that polydactylism and syndactylism were mainly related to recovery processes following x-ray damage. (TSS) (NSA of Japan)

22398 ALTERATION IN THE BONE TISSUE AND SOME OTHER ENDOCRINE ORGANS UNDER THE INFLUENCE OF THORIUM BIOXIDE. Zedgenidze, G. A.; Amosov, I. S.; Soboleva, E. L.; Tkachev, A. V. (Inst. of Medical Radiology, Moscow). Med. Radiol., 13: No. 12, 46-9(Dec. 1968). (In Russian).

Changes in the skeletal bones, hypothalamo-hypophyseal region and thyroid gland in rats 18 months after intravenous administration of 4 ml of thorotrast were investigated. X ray, microroentgenographic and morphological methods of investigation were employed. The features peculiar to primary deposition and subsequent intraosseous redistribution of thorium bioxide are described in accordance with data of intravital numerous x ray investigations. Fibrous dystrophia of the bones and polymorphocellular sarcomas developed in the zones of large foci of thorium bioxide accumulation. At the beginning of the second year after introduction there were found thorium lumps in the adenohypophysis. Thorotrast accumulation in the thyroid gland was insignificant and observed inconstantly, however, 1½ years later in the latter a massive proliferation of the connective tissue was seen. A supposition is made that dystrophic changes in the bone tissue and spontaneous necroses of peripheral regions of the extremities and tail are associated not only with alteration and disturbance of the vascular patency, but also with radiation injury of the hypothalamo-hypophyseal system as the result of chronic effect of alpha and gamma radiation of thorium. (auth) (C.O.)

22399 RADIATION-INDUCED THYROID DYSFUNCTION IN THE DOG. Michaelson, Sol M.; Quinlan, William Jr.; Casarett, George W.; Mason, W. B. (Univ. of Rochester, N. Y.). Contract W-7401-eng-49; DASAMD 960. Radiat. Res., 30: 38-47 (Jan. 1967). (UR-49-734).

Exposure of the upper part of the body of the dog to 1200 to 2100 R of 1000-kVp x rays resulted in hypothyroidism between two and four years after irradiation. The pathogenesis of the radioinduced thyroid defect was not clearly defined, but evidence for this defect was supported by clinical signs and thyroid function studies. Among dogs irradiated with 1215 R there was a significant depression of ^{131}I uptake three years after exposure. Variable ^{131}I uptake was seen for the first seven months after exposure to 1820 R. At three and four years the uptake was minimal. Most of the irradiated dogs had minimal to low ^{131}I uptake before TSH, and poor response to TSH administration. PBI levels following TSH administration also indicated little stimulation. Necropsy examination three years after upper-body exposure to 1820 R revealed that the thyroid glands were markedly reduced in size, hard, and nodular. From microscopic examination of the thyroids it was evident that a large majority of the follicles had undergone marked atrophy, follicles showing varying degrees of degeneration, sloughing and loss of epithelium, thickening of basement membrane, interstitial fibrosis, and perivascular fibrosis. Follicles containing any colloid were rare. The differential diagnosis of primary hypothyroidism was based on refractoriness to exogenous TSH administration. (auth)

22400 SKIN AND CARBON DIOXIDE LASER RADIATION. Brownell, A. S.; Parr, W. H.; Hysell, D. K. (Army Medical Research Lab., Fort Knox, Ky.). Arch. Environ. Health, 18: 437-42(Mar. 1969).

Dose-response relationships for the induction of thermal lesions in porcine skin by carbon dioxide laser radiation were determined and considered adequate to establish laser safety standards for skin burn injuries within the exposure time of range of 0.2 to 50 seconds. Although the data suggested that for exposure times of less than 0.2 seconds the threshold value to produce mild erythema is approximately 3 J/sq cm, caution should be exercised in extrapolating these data in this manner until further data for still shorter times become available. (auth)

22401 LASER EFFECTS ON THE EYE. Clarke, A. M.; Ham, William T. Jr.; Geeraets, Walter J.; Williams, R. C.; Meuller, Harold A. (Medical Coll. of Virginia, Richmond). Arch. Environ. Health, 18: 424-7(Mar. 1969).

Safe levels of illumination that may be presented to the eye were investigated. Over 500 rabbits were exposed to a modified Zeiss coagulator and to a ruby or neodymium laser. Wide ranges of exposure times and retinal image sizes were used. From the results it was apparent that the threshold for minimal ophthalmoscopic lesions depends on the size of the irradiated area of the retina and the interval of exposure as well as the energy density. Therefore criteria for safety must be evaluated with this in mind. Thermal models and their use in calculation of threshold dose are discussed. Data are given that determine exposure levels at which ophthalmoscopically visible lesions occur. Extrapolation of these data can specify a level at which small lesions should occur, although they may be too small to detect. It is believed that other optical sources, whether laser or white light, will not differ significantly from the obtained values for irreparable damage to the mammalian eye. (C.O.)

22402 THE EFFECT OF TRAUMA IN THE COURSE OF THE RADIATION SYNDROME (EXPERIMENTAL PRINCIPLES). Messerschmidt, O. (Univ., Freiburg i. B.). pp 75-80 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Combination injuries caused by radiation incidents are evaluated on the basis of animal experiments. Interaction between x-radiation and open skin wounds is discussed for mice as demonstrated by a table. Mortality rate is determined more by the interval between x-radiation and infliction of wounds than by radiation dose. Experiments involving combination injury cases are reviewed. (H.B.G.)

22403 HISTO-MORPHOLOGICAL CHANGES IN THE DENTAL SYSTEM OF DOGS IN ACUTE EXPERIMENTAL RADIATION SICKNESS. Datschew, Bogdan; Kiprow, D. (Balkandchi Jovostrasse, Sofia). Deut. Stomatol., 17: 806-15(Nov. 1967). (In German).

Radiosensitivity of tissues of the maxillodental system was studied in wolfhounds x irradiated with doses from 800 to 1200 R over the entire chest and abdominal area. There were no microscopic changes in the enamel, dentine, or cementum, but the jawbones became hyperemic. No severe irradiation injuries were observed in the tissue surrounding a previously cemented bridge. The leukocyte and erythrocyte counts decreased. Inflammatory reactions were observed in the periodontia, with easily and rapid changes in the gingiva and oral mucosa, consisting of swelling, hemorrhagic inflammation, and bleeding from the gingiva and mucosa. The gingiva became infiltrated with lymphocytes, and plasma cells were found in the periodontal pockets as far as the papillary apices. The periodontium was hyperemic and in some areas there were inflammatory connective tissue reactions at the apices of the roots and on both sides of the teeth. Frequently, the pulps were hyperemic and bled, without changes in the odontoblast layer. No changes were observed in the enamel. Except for hyperemia, there were no changes in the bone marrow or the structure of the alveolar trabeculae and jaws. (BBB)

22404 FINE STRUCTURE OF THE BONE MARROW AFTER WHOLE-BODY IRRADIATION. **Huhn, D. (Institut fuer Haematologie, Munich). Blut, 16: 121-43(Dec. 1967). (In German).**

The fine structure of rat bone marrow 1 to 24 hr after whole-body x irradiation with a dose of 800 R is described. Atypical chromatin distribution and mitotic figures of the nucleus and increased activity of the phagocytic reticulum cells were found within 2 to 5 hr after irradiation. The sinuses wall was dilated after 5 hr, and after 24 hr the continuity of the sinus wall was interrupted and there was marrow hemorrhage. After 2 hr vacuolar enlargements of the mitochondria, myelin figures, and vacuole-like degeneration of the processes of sinus endothelial cells were observed. Up to 5 hr after irradiation distribution of injected C particles was normal, but after 24 hr their distribution was uniform throughout the marrow. After 1½ hr the parenchymal cells showed mitochondrial enlargements with degeneration of the cristae. Abnormal distribution of chromatin, atypical divisions and phagocytosis by reticular cells were observed. The chromatin was clumped and homogenized, with nuclear protrusions. The phagocytic reticular cells were relatively radioresistant. Lesions of the blood vessels in the marrow were infrequent during the first 5 hr after irradiation. The results were discussed with reference to the enzyme release theory of irradiation effect. References cited, 42. (BBB)

22405 BONE MARROW INJURY AND REPAIR: IRRADIATION AND MECHANICAL DISRUPTION. **Weinstein, M. B.; Crosby, W. H. (New England Medical Center Hospitals, Boston). Acta Haematol., 40: 55-8(1968).**

Exposure of the femur and tibia of the rat to 4000 R of x irradiation resulted in permanent aplasia of the bone marrow. Two months postirradiation, when the aplasia is well established, autologous marrow removed from an unirradiated bone and implanted in the irradiated area can reconstitute hemopoietic activity. Whether normal marrow from the shielded portion of an irradiated bone could be induced by mechanical mixing to proliferate in the aplastic portion, was ascertained. Half of the tibia of rats was x irradiated with 4000 R and a wire passed into the tibia marrow cavity was used to mix the contents. Those bones in which the marrow was not mechanically disrupted were examined at intervals up to 8 weeks after irradiation and the typical cycle of changes was observed: sinusoidal dilation, intramedullary hemorrhages, hyperplasia and then hypoplasia. In all of the irradiated tibias there was a line of demarcation by the 8th week; in the distal end of the cavity the hemopoietic marrow was replaced by loose connective tissue, rare lymphocytes and plasma cells, and few erythrocytes. The proximal end contained normal marrow. When mechanical disruption of the left tibial marrow followed irradiation by 1 to 2 weeks, hemopoietic cells were found in the irradiated areas 4 to 15 weeks postoperatively. Hemopoietic tissue and trabecular bone were present through the entire length of the cavity. In some bones islands of normal tissue were scattered among aplastic areas. When disruption followed irradiation by 4 weeks, there was recovery of hemopoiesis in the distal cavity of some animals, but not all. When disruption followed irradiation by 6 to 8 weeks, there was only fatty and connective tissue in the distal end of the cavity 2 to 10 weeks postoperatively. (BBB)

22406 RADIATION-INDUCED ASYMMETRY AND LYMPHOMA OF THYMUS IN MICE. **Jaerplid, Bertil (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Radiol., Suppl. 279, 1-98(1968).**

Development of radiation-induced leukemia was studied in C3H mice x irradiated with 550 R either as a single dose or in four equal doses every fifth day. Morphological changes in hematopoietic tissues and leukemogenic effects were compared. Cell destruction, depletion, and regeneration were more pronounced after single than fractionated irradiation. The chief differences between the two groups was in the thymus, which after irradiation regenerated diphasically in size, weight, and histology. After a single dose irradiation the regeneration was symmetrical and complete, but after fractionated irradiation the thymus regenerated asynchronously in 30% of cases, leading to early asymmetry, with considerable differences in size and weight of the two lobes. Regeneration of irradiated thymus appeared to be dependent on a supply of repopulating cells from the circulation. Asymmetry could be prevented by thigh shielding during irradiation or by injection of bone marrow cells 5 hr to 2 days after irradiation. The asymmetry was apparently caused by incomplete regeneration. Fractionated irradiation may lead to survival of a larger number of defective or modified cells than single dose irradiation. Simultaneously with late asymmetry lymphoma appeared in the thymus. The lymphoma could not be transmitted with cell-free extract to newborn syngenic mice. After fractionated irradiation of young mice, 29% developed thymic lymphoma and 2% nonthymic lymphoma. Bone marrow showed no distinct differences between the different modes of irradiation. Extramedullary granulopoiesis in the lymph nodes on day 20 to 28 and nodular formation and vigorous compensatory hyperplasia of the spleen on day 17 to 20 were seen after single dose irradiation but not after fractionated irradiation. The spontaneous incidence of other tumors (10.7%) increased only after single-dose irradiation, especially of adult animals (33%). Adenoma in lungs and adrenal cortex, fibrosarcoma, and angiosarcoma predominated. Both modes of irradiation shortened mean life span. (BBB)

22407 THE EFFECT OF A COMBINED THERAPY WITH SP-1 SANDOZ AND X IRRADIATION ON EXPERIMENTAL SARCOMA 37 OF THE MOUSE. **Berz, A. (Univ., Basel). Dermatologica, 136: 368-82(1968). (In German).**

Results of combined treatment of sarcoma 37 in mice with 1000 R of x irradiation and the ethyl hydrazide of podophyllinic acid (SP-1), a cytostatic agent, are reported and discussed. The average tumor wt was 1.24 g as compared to 2.78 in the controls and ~1.8 g in animals treated with either irradiation or SP-1 alone. The wt fraction of the tumor in a compact state was ~10%, and ~20% was in stage II. The general condition of the animals was poor. The combined results indicated that ~80 to 95% inhibition of the tumor was obtained after the combined treatment. However, some of the animals appeared to be strongly affected by this treatment; they developed diarrhea and lost ~25% of their body wt. The effects of SP-1 and the irradiation appeared to be additive and induced secondary, generalized toxic effects. (BBB)

22408 DIFFERENTIAL RADIOSENSITIVITY OF GERM-CELLS OF THE MALE MOUSE. **Leonard, A. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Can. J. Genet. Cytol., 7: 400-5(Sept. 1965). (BLG-377).**

Male mice of the BALB/C$^+$ strain were irradiated on the testis with 300 R of x-rays and during 8 weeks mated with virgin females. The females were exchanged for virgin females twice a week. Seventeen days after they were put into the cages with the males, the females were dissected and the number of corpora lutea and the living and dead embryos recorded. The fertility appeared to decrease with the time after irradiation and was the lowest after 6 weeks. The preimplantation loss was at a maximum of 4, 5, and 6 weeks after treatment. It is conceivable that preimplantation loss is caused by a loss of fertilizing capacity of the sperm irradiated at the spermatocyte stage. The post-implantation loss showed that the hypersensitivity period affects the spermatids at all stages. (auth)

22409 SOME HISTOCHEMICAL REACTIONS IN THE RAT ADRENAL GLAND CORTEX CHANGED BY A SINGLE X-RAY DOSE. **Mietkiewski, K.; Brzezinski, R. (Medical Academy, Poznan, Poland). Folia Histochem. Cytochem. (Krakow), 6: 195-202(1968).**

The adrenal cortex of x-irradiated rats (a single dose of 900 R given on the entire body) was histochemically studied 24 hours later. The demonstration of lipids, α-ketolic steroid groups, and Golgi structures, together with that of acid phosphatase, DNase II and ATPase was accomplished. Histological sections were stained with haematoxylin and eosin. In the treated animals some of the adrenal cortex nuclei became pyknotic and underwent chromatolysis. The x-ray dose applied caused partial involution of the Golgi apparatus. In the zona fasciculata of the adrenal cortex a diminution in the intensity of the reactions for lipids and α-ketolic steroids was observed; on the other hand, the color reactions for phospholipids became slightly intensified, particularly in the zona glomerulosa. Thus it may be inferred that the applied x-ray dose induced deterioration in the activities of the enzymes examined, chiefly in the zona fasciculata. Conclusions may be drawn that justify the assumption that in rats subjected to a single 900 R dose of x-rays disturbances in both synthesis and secretion of corticosteroids occur. (auth)

22410 INFLUENCE OF LETHAL DOSES OF X RADIATION ON METAMORPHOSED AND NEOTENIC ALPIN TRITONS. **Svob, T.; Kilalic, T. (Univ., Sarajevu, Yugoslavia). Bull. Sci., Sect. A, 12: No. 5-6, 125-6(1967). (In Slovak).**

Groups of metamorphosed Alpine salamanders and of neotenic Salamanders were irradiated at doses from 1000 to 16000 R and with lethal doses. No significant differences were noted in the lethal doses for metamorphosed and neotenic salamanders. (M.C.G.)

22411 THE THYMUS: A HEMATOPOIETIC ORGAN. II. THE ROLE OF THE THYMUS IN THE REGENERATION OF LYMPHO- AND GRANDULOCYTOPOIESIS AFTER SUBLETHAL IRRADIATION IN MICE. **Schneiberg, Krzysztof; Jonecko, Antoni; Bartnikowa, Wieslawa (Inst of Oncology, Gliwice, Poland). Folia Haematol. (Leipzig), 88: 260-74(1967). (In French).**

Periodical peripheral blood and bone marrow examinations revealed an insufficient granulocytopoiesis in mice thymectomized at the age of 3 weeks and irradiated with a whole-body dose of 500 R x-rays 1 month later. It may be concluded that the reduced natural radioresistance of these animals is due to this primary lesion. It is concluded that the thymus is a hematopoietic organ in a young animal. Later on in life, this hematopoietic function of the thymus is limited to lymphopoiesis only. (auth)

22412 EFFECT OF RADIATION ON THE NAIL TISSUE. PART II. **Adachi, Tadashi; Haruyama, Kazuhisa (Tokyo Medical and Dental Univ.). Bull. Tokyo Med. Dent. Univ., 15: 29-31(Mar. 1968).**

The ridging of the nail plate in chronic radiation damage of the nail may be caused by the combination of radiation injury to the nail matrix, hyponychium, and nail lamellae. Fragility may result from frequent interruption of mitosis in the nail matrix. The thickening of the nail plate was not observed in this experiment. The thickening of nail plate reported in man associated with chronic radiation damage to nail can be explained by slowing down of forward movement of nail plate, incompleteness of successive cell differentiation and coarseness of the nail plate. Various changes of nail reported as a chronic radiation injury of nail in man seem to be caused by fractionated irradiation in the experimental animal. (auth)

22413 MORPHOLOGY AND CLASSIFICATION OF THE CARDIOVASCULAR ANOMALIES INDUCED BY 14.1 MeV NEUTRON IRRADIATION. **Okamoto, Naomasa (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol., No. 9, 25-42(1968). (In Japanese).**

Pregnant rats were given single doses of whole-body neutron radiation of 80, 100, and 130 rad between the seventh and eleventh day of gestation. On the 18th day, the fetuses were dissected or serially sectioned for histologic study. Cardiovascular anomalies were found in 496 of 1077 fetuses. The anomalies were classified as follows: transposition complexes (230), ventricular septal defects (195), aortic arch anomalies (161), truncus arteriosus communis (9), pseudotruncus arteriosus communis (4), tricuspidal atresia (2), hypoplasia of aorta (4), hypoplasia of pulmonary trunk (8), ectopia cordis (8), dextrodardia (1), and anomaly of coronary vein (1). Neutron irradiation resulted in a greater number and variety of anomalies than treatment with trypan blue or x radiation. (E.L.W.)

22414 EFFECT OF IRRADIATION AND NEONATAL THYMECTOMY ON GROWTH OF POLYOMA TUMORS IN RABBITS. **Irlin, I. S.; Ter-Grigorov, V. S. (Inst. of Epidemiology and Microbiology, Moscow). Vop. Onkol., 15: No. 2, 42-6(1969). (In Russian).**

The treatment of newborn rabbits by x-irradiation or thymectomy causing the suppression of immunoreactivity does not principally change the character of initial tumor growth but greatly stimulates the tumor progress. Failure in obtaining the immune response in rabbits subjected to x-radiation at the age of 3 weeks old could account for induction of polyoma tumors of invasive and progressive character. According to histological findings interruption of the growth and subsequent involution of tumors are relative to the progressive development of cellular reactions characteristic of a delayed-type sensitivity. In progressive invasive tumors developed in animals with presumably suppressed immune reactivity no cellular reactions of immunomorphological type could be revealed. (auth)

22415 A PHYSIOLOGICAL AND ANATOMICAL STUDY AFTER PULMONARY IRRADIATION IN DOGS. **Hooykaas, J. A. P.; Benfield, John R.; Wolfe, Steven F.; French, Samuel W.; Crummy, Andrew B. Jr. (Harbor General Hospital, Torrance, Calif.). Dis. Chest, 55: 123-6(Feb. 1969).**

Physiological and anatomical changes following unilateral pulmonary ^{137}Cs γ irradiation up to 6000 RAD in dogs were studied. Fractionated irradiation doses were given to the right lung of 11 dogs divided into three groups which received 2000, 4000, and 6000 RAD, respectively. Differential bronchospirometry was serially performed at four-week intervals for one yr. There was no significant change in the relative distribution of ventilation and oxygen uptake between the irradiated and the contralateral control lungs. Upon diversion of the entire cardiac output through the irradiated lung by temporary unilateral pulmonary artery occlusion, pulmonary artery pressure and left arterial pressure remained within normal limits. Thus, there was no suggestion of increased pulmonary vascular resistance as a consequence of irradiation. Neither adhesions nor abnormalities of the bronchial vessels were observed. The microscopic findings consisted of focal organized pneumonia which was found only in the 4000- and 6000-RAD groups, and mild focal interstitial fibrosis plus focal vascular sclerosis found in representatives of each of the three groups. It was concluded that there were no significant physiological abnormalities following unilateral pulmonary irradiation up to 6000 RAD. (BBB)

22416 AVIAN THYROID DESTRUCTION BY RADIOIODINE. **O'Niell, Timothy J.; Chiasson, Robert B. (Univ. of California, Los Angeles). Poultry Sci., 47: 911-5(May 1968).**

Radioiodine is found to be the cause of thyroid follicle destruction in 23- and 63-day-old White Leghorn cockerels. The relation between the isotope injection dose and the percent of lateral destruction was linear. The longitudinal destruction was constant (65% of total length) in all cases. An inverse correlation was found between total body weight and injected concentrations of Na^{131}I. The radioiodine content of the thyroid glands at autopsy revealed a direct relation with injection dose. Glandular damage as a function of postinjection time showed no clear-cut pattern in the older cockerels. It is concluded that radioisotopes when used as metabolic tracers are capable of inflicting measurable damage upon the avian thyroid gland. (BBB)

22417 EFFECT OF EMBRYONIC ADMINISTRATION OF ^{131}I UPON REPRODUCTIVE PERFORMANCE OF THE WHITE LEGHORN. **Mraz, Frank R. (Univ. of Tennessee, Oak Ridge). Poultry Sci., 47: 916-9(May 1968).**

Whether ^{131}I administered to chick embryos would permanently affect their thyroids and affect their reproductive capacity as adults, was investigated. White Leghorn embryos were injected with 0, 1, 2, 5, 25, or 50 μCi^{131}I at the 16th day of incubation. Some of those that hatched were killed at six, 16, or 68 weeks of age and their thyroids removed. Six-month egg production by females and fertility of nine-month-old males were determined. Generally 25 or more μCi^{131}I reduced body size, thyroid size, and thyroid uptake of ^{131}I. The birds showed evidence of hypothyroidism and were fat. Reduced thyroid uptake of ^{131}I was also apparent in the 5-μCi group at six and 16 weeks of age. The administration of 5 μCi^{131}I or less to 16-day embryos had no effect on their viability or egg production while 25 or more μCi reduced both. Fertility of the males as determined through artificial insemination was not impaired by 50 μCi^{131}I administered at 16 days of incubation. (BBB)

22418 THE EXPERIMENTAL PRODUCTION OF PAROTID GLAND ATROPHY. **Wallenborn, White McK.; Hsu, Y. T.; Olinger, B. Ray (Univ. of Virginia, Charlottesville). Laryngoscope, 73: 1314-28(Aug. 1968).**

Irradiation and two other methods were used to cause atrophy of parotid gland in rabbits. Utilizing a 200-kV x-ray therapy unit, rabbit parotid glands were given 500, 1000, or 2000 R. The irradiation dose was administered weekly over a one, two, and three-week period, respectively. At varying intervals ranging from five to 77 weeks, the glands were removed for histopathological examination. The results after ligation of Stensen's duct and the transtympanic destruction of the tympanic plexus (tympanic neurectomy), were compared with those of irradiation. Irradiation caused significant parotid atrophy in 10 out of 10 animals treated. This technique produced rapid atrophy of the gland. Ligation of the parotid duct also was shown to be capable of effecting significant atrophy of the parotid in 23 out of 25 rabbits. The more marked atrophy developed consistently 19 weeks or more after the ligation. The transtympanic destruction of the tympanic plexus, which interrupts the parasympathetic innervation to the parotid gland, was shown to cause significant glandular atrophy in the parotids of 60 out of 61 rabbits. The more marked atrophic changes occurred after 25 weeks postsurgery. Discussion of the combined tympanic neurectomy and chorda tympani nerve section as the preferred method of production of parotid atrophy and secretory arrest is included. The clinical application of these techniques for certain diseases, disorders, and traumatic injuries of the parotid gland was discussed. (BBB)

22419 THE BIOLOGICAL BEHAVIOR OF ^{239}PuO$_2$ PARTICLES: ROLE OF THE PERITONEAL MONONUCLEAR PHAGOCYTE. **Sanders, Charles L. (Battelle-Northwest, Richland, Wash.). Radiat. Res., 38: 125-39(Apr. 1969).**

Plutonium-239 dioxide particles injected into the peritoneal cavity of rats were rapidly phagocytized by peritoneal mononuclear phagocytes. A marked accumulation of particles within phagocytes was demonstrated by electron microscopy. The average active phagocyte had engulfed the equivalent of approximately 500 particles, 0.12 micron in diameter, at 3 to 7 hours after administration. This represents an amount of ^{239}Pu that would deliver an estimated alpha dose to the phagocyte of about 225 Rads/hour. Early marked ultrastructural damage was observed in many phagocytes, engulfing large amounts of plutonium particles. The plutonium-laden phagocytes traveled to the omentum and mesentery, where they accumulated within lymphatic nodules. A partial release of plutonium particles from the omentum and mesentery back into the peritoneal cavity was observed at 1 to 4 weeks. The phagocyte plays a very important role in determining the early behavior of plutonium particles in the peritoneal cavity. (auth)

22420 EARLY VASCULAR INJURY IN THE IRRADIATED CHICK EMBRYO: EFFECT OF EXPOSURE TIME. Stearner, S. Phyllis; Christian, Emily J. B. (Argonne National Lab., Ill.). Radiat. Res., 38: 153-60(Apr. 1969).

The early response to lethal doses of ionizing radiation in the chicken and chick embryo is characterized by rapid structural and functional changes in the vascular system. Increase in exposure time from a few minutes to a few hours has been shown to reduce the dose effectiveness for this injury mechanism. An x-ray exposure to 1100 R delivered in 12 minutes resulted in more than 95% mortality within 24 hours; when the exposure time was increased to 240 minutes, 1100 R represented a sublethal dose, 1800 R a 50% lethal dose, and 2200 R a 95% lethal dose. Effects of these exposures on the microcirculation were studied in the explanted chick embryo. The extent of injury to the vascular system could be correlated with the amount of lethality produced by the irradiation. A 240-minute exposure to 1100 R produced little effect on the microcirculation. Only after exposure to 2200 R was there a rapid circulatory collapse comparable to that produced by a 12-minute exposure to only 1100 R. Degenerative changes in individual endothelial cells appeared to be a direct effect, which was reduced when the exposure time was increased. (auth)

22421 FURTHER STUDIES ON THE RESPONSE OF THE SMALL INTESTINE TO CONTINUOUS IRRADIATION. Cairnie, A. B. (Inst. of Cancer Research, Surrey, Eng.). Radiat. Res., 38: 82-94(Apr. 1969).

Rats were irradiated continuously at 350 Rads/day by a ^{137}Cs source. The length of $(G_2 + \frac{1}{2} M)$, the part of the cell cycle between the end of DNA synthesis and division, was measured in the epithelial cells of the jejunum. It increased on the first day of irradiation and then partially recovered. The rate of cell production in the crypt showed a simultaneous dip and recovery. In another experiment mice were irradiated continuously at 325 Rads/day for 20 hours, 2 days, or 3 days. They then received one of a graded series of doses given at 30 Rads/min to establish median doses lethal in 5 days ($LD_{50(5)}$). Only the 2-day group had a significantly lower $LD_{50(5)}$ than the control group ($P < 0.05$). These results support the concepts that there is a partial recovery in proliferative activity in the continuously irradiated intestine after the first day and there is little damage accumulated in the intestine irradiated with γ-rays at a dose rate of 325 Rads/day for up to 3 days. (auth)

22422 RADIATION EFFECTS ON COLD-INDUCED GROWTH RESPONSE OF INTERSCAPULAR BROWN FAT. Thomson, John F.; Nance, Sharron L.; Beetham, Karen L. (Argonne National Lab., Ill.). Radiat. Res., 38: 55-64(Apr. 1969).

When rats are transferred to a 5°C environment immediately after exposure to 400 R of x-irradiation, the rate of growth of interscapular brown fat is significantly inhibited, in comparison with that in pair-fed unirradiated cold-exposed controls. The most striking effect is on the early hyperplasia of the tissue, which in the controls is maximal after 3 days in the cold. After 3 weeks, the mass of interscapular brown fat in the irradiated animals is only slightly less than that in control rats, but the total amounts of various components of the tissue (total nitrogen, nucleic acids, phospholipids, respiratory enzymes) remain below the control level for at least 5 weeks. It seems unlikely that decreased thermogenic activity is of major importance in reducing the survival of cold-exposed irradiated rats. (auth)

22423 CELL POPULATION ANALYSIS OF RADIATION DAMAGE AND RECOVERY OF THYMUS AND LYMPH NODES IN MICE. Sato, Chikako; Sakka, Masatoshi (Tohoku Univ., Sendai). Radiat. Res., 38: 204-13(Apr. 1969).

C57BL/6 mice received whole-body x irradiation, and differential cell counts were made on cellular suspensions of the lymphatic tissues at regular intervals. A two-phase pattern of thymic lymphopoiesis was demonstrated: The first phase of blast cell proliferation lasted for three to four generations and was followed by a period of differentiation to small lymphocytes. The difference in the time of repopulation between the thymus and the lymph nodes was ascribed to the difference in the absolute number and the doubling time of primitive cells. The doubling time of blast cells was 12 hours in thymus and 20 hours in lymph nodes. The relation between dose and the number of surviving cells at 24 hours after irradiation revealed the existence of two classes of lymphocytes with different radiosensitivity. The D_{37} was 145 R and 425 R for small lymphocytes and 57 R and 520 R for medium and large lymphocytes in thymus. The D_{37} values for small and larger lymphocytes in lymph nodes were 213 R and 200 R, respectively. (auth)

22424 AUTORADIOGRAPHIC STUDIES OF DNA SYNTHESIS IN EMBRYONAL CEREBRUM AFTER SINGLE X IRRADIATION IN THE LATE EMBRYONIC AND FETAL STAGES OF THE RAT. Wegner, G.; Mecking, H. (Univ., Freiburg i. B.). Z. Gesam. Exp. Med., 149: 2-12(Jan. 8, 1969). (In German).

Autoradiographic studies on cerebrum of late embryonic stages revealed a 75%-decrease of the number of DNA-synthesizing cells after x irradiation (150 R) during the first 5 hr when compared with the controls. The labeling index remained depressed up to 15 hr after irradiation. Thereafter the ^{3}H index approached control values. The number of mitotic cells decreased up to 48 hr. Development of moderate internal hydrocephalus and so-called rosettes (localized regenerations) are described as indication of permanent lesions. After irradiation of late fetal stages (18th day) the x-ray sensitivity was found to have decreased markedly. The number of DNA-synthesizing cells was depressed (30%) for short periods (2 hr) only. The reduction of mitoses was much smaller and transient. A comparison of the ^{3}H index values postirradiation with the phases of the embryonic generation time indicated a short-term x-ray-induced depression of DNA-synthesis (S-phase) and of the presynthetic G_1-phase. The 48-hr reduction of the mitotic cell number is a later manifestation of these changes. Irradiation at the 18th day of embryonic development no longer affected the cell generation times. (BBB)

22425 EXTRACORPOREAL IRRADIATION OF THE BLOOD IN BABOONS. Storb, R.; Ragde, H.; Thomas, E. D. (Univ. of Washington, Seattle. Public Health Service Hospital, Seattle). Radiat. Res., 38: 43-54(Apr. 1969).

Continuous extracorporeal irradiation of the blood (ECI) for 10 to 21 days was carried out in baboons by means of an x-ray irradiator without a pump or anticoagulation. One baboon received a daily cumulative dose of 20,000 R to the red blood cells and died on the tenth day with severe hemolysis. Baboons given 10,000 R daily tolerated the irradiation well but showed severe hemolytic anemia. Prompt, pronounced, and long-lasting lymphocytopenia was observed. No consistent changes in platelet or granulocyte levels were noted. By the tenth day lymph nodes in all baboons had undergone atrophy involving both germinal centers and adjacent areas. Lymphoid hypoplasia lasted for more than 2 months. Allogeneic skin grafts survived for 7 to 12 days in untreated baboons. In a treated baboon, allogeneic skin grafted on day 2 of ECI was rejected after 15 days despite continuous ECI. Three treated baboons received skin grafts on day 10 and showed graft survival of 41 to 53 days despite discontinuation of ECI. No difference in antibody formation against sheep red blood cells was found between ECI-treated and untreated baboons. Surviving animals were observed for more than 300 days without apparent late sequelae. (auth)

Man

Refer also to abstracts 22159, 22167, 22168, 22270, 22296, 22324, and 22328.

22426 (ANL-7531) THE ARGONNE RADIUM STUDIES. Summary of Fundamental Data. Miller, Charles E. (Argonne National Lab., Ill.); Hasterlik, Robert J. (Argonne Cancer Research Hospital, Chicago, Ill.); Finkel, Asher J. (Argonne National Lab., Ill.). Jan. 1969. Contract W-31-109-eng-38. 596p. (ACRH-106). Dep. CFSTI.

Data are summarized on the radium body content, source of exposure, ^{226}Ra retention patterns, and medical consequences of internal occupational exposure after 35 to 50 years. Results of whole-body γ counting of ^{214}Pb and ^{214}Bi and analyses of breath for Rn content were used when possible to calculate body burden. Skeletal radiographs and special mastoid or paranasal sinus laminography were used to detect pathological effects in bones. Tumor diagnosis and blood dyscrasias were established by examination of tissues or smears or from interpretation of the available clinical history. Autopsy material was also examined when available. Essential portions of the information accumulated were stored on magnetic tape to facilitate rapid computer retrieval of selected data. (C.H.)

22427 INDICATIONS FOR THE HEMATOLOGICAL MONITORING OF RADIATION INJURY. Stodtmeister, R. (Staedtischen Krankenhauses Pforzheim, Ger.). pp 108-9 of Aerztliche

Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

The question is raised whether bone marrow after radiation exposure is normal or more susceptible to further damage. Indications are that the latter is the case. Degeneration of the marrow after sublethal doses, when treated with bone marrow transfusions, is probably due to immunologic reactions, as shown in total body irradiation experiments with rats. (H.B.G.)

22428 PATHOPHYSIOLOGICAL EFFECTS ON THE BONE MARROW IN EXTRAORDINARY LOCAL RADIATION BURDEN. Chone, B. (Univ., Heidelberg). pp 109-14 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

Daily doses of 300 rad gamma radiation were administered locally to cancer patients until a total dose of 5000 rad was reached. The peripheral blood picture showed no significant change. In the irradiated area, the bone marrow revealed early effects (mitotic inhibition, karyolysis, giant cell formation etc.), which progressed to almost total replacement of the marrow by fibrous and fatty tissues. Not infrequently, recovery of the marrow and hematopoiesis occurred between one to two years after exposure. (H.B.G.)

22429 INDICATIONS FOR THE BIOCHEMICAL DIAGNOSIS OF RADIATION INJURY. Gerber, G. B. (EURATOM, Mol, Bel. C.E.N., Mol, Bel.). pp 134-6 of Aerztliche Massnahmen bei Aussergewoehnlicher Strahlenbelastung. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, Georg Thieme Verlag, 1967. (In German).

From Conference on Medical Measures for Unusual Radiation Burdens, Freiburg, Germany. See CONF-661057.

At present, biochemical methods are inferior to hematological procedures for the assessment of radiation injury. To improve the situation, experimental conditions should be standardized as to: animal care, types of radiation, and analytical chemical methods. A central European standardization center might solve the problem. (H.B.G.)

22430 RADIATION-INDUCED ABNORMALITIES IN HUMAN DEVELOPMENT. Brill, A. Bertrand; Nance, Walter E.; Engel, Eric; Glasser, Stanley R.; Forgotson, E. H. Advan. Obstet. Gynecol., 1: 69-87(1967).

A review is presented of the somatic effects of ionizing radiation, effects of radiation on mammalian prenatal development, and experimental studies on animals. Mechanisms of radiation injury are reviewed with emphasis on the radiosensitivity of nucleic acids. Effects of radiation on chromosomes are discussed, including effects on morphology and number and effects on sex chromosomes. The value of iris heterochromia as an index of in utero radiation exposure is discussed. The relationship between radioinduced teratogenesis and carcinogenesis is discussed. Effects of background, diagnostic, and therapeutic radiation on mammalian prenatal development are discussed. It is pointed out that the available data indicate that it is not yet certain that the doses used in diagnostic procedures constitute a measurable hazard. Studies on Japanese survivors of atomic bombings included a study of children who were in utero at the time of the bombing. It was found that the more heavily exposed individuals were smaller than the less heavily exposed. Experimental studies on animals are reviewed with regard to prenatal death, developmental malformations, placental effects, and effects of internal emitters. A list of 128 references is included. (H.L.W.)

22431 PULMONARY CHANGES AFTER RADIATION TREATMENT IN PATIENTS WITH CANCER OF THE MAMMARY GLAND. Pereslegin, I. A.; Merman, A. M.; Ryazanskaya, G. V. (Medical Inst., Moscow). Vop. Onkol., 15: No. 2, 23-7(1969). (In Russian).

Clinico-roentgenological analyses of the data are presented on 113 patients with cancer of the mammary gland in whom post-radiation pulmonary complications were observed. Great attention is given to the necessity of differentiation between these changes and primary cancer of the lung and pneumonias. Basic clinical and roentgenological signs of post-radiation complications are described. Pneumosclerosis occurred more frequently in gamma therapy even following one course of irradiation; that mainly accounted for great penetrative power of this kind of radiation and greater total focal absorbed doses. (auth)

22432 EFFECT OF TOTAL DISTANT SOLAR ECLIPSE AND SOLAR FLARES ON BLOOD COAGULATION IN NORMAL SUBJECTS. Tempka, Tadeusz; Kostkowski, Andrzej; Rybka, Eugeniusz (Jagellonian Univ., Krakow). Pol. Arch. Med. Wewn., 36: 525-34(1966). (In Polish).

Studies were done on two mature healthy female and one male subject, to observe changes in the thromboelastogram and electrophoretogram of blood serum during the 1961 and 1962 solar eclipses and flares. It is pointed out that solar radiation includes x rays, uv, ir, and corpuscular radiation, and that their intensity is affected by sun spots intensified in 11-yr cycles. Also, solar magnetism changes occur in 22-yr cycles. During solar flares uv rays and corpuscular radiation are especially intensified. The corpuscular radiation is divided into two categories: solar flares that may create high-energy particles which travel toward earth at speeds from 500 to 1000 Km/sec, and a steady flow of particles traveling toward earth at 200 Km/sec (the solar wind). The investigation showed that total solar eclipses accelerated thromboplastinogenesis and thrombinogenesis up to 58 hr from the beginning of the eclipse, while the rate of thrombogenesis decreased. Quantitatively, the changes in serum protein fractions, particularly of α_1- and α_2-globulins decreased considerably, resulting in relative increments of γ-globulin. The solar flares of the corpuscular radiation had an even greater effect on coagulation factors, i.e., thromboplastinogenesis, thrombinogenesis, and thrombogenesis showed considerable delay up to 58 hr. The serum protein fractions showed the same oscillations as seen during the sun eclipses with respect to the α_1- and α_2-globulins, with resulting changes in the serum albumin level. (BBB)

Radiation Effects on Plants

Refer also to abstracts 22223, 22236, 22251, 22253, 22267–22269, and 22448.

22433 (BMwF-FBK-68-48) THE EFFECT OF LOW DOSES OF γ-RADIATION ON PLANT GROWTH. Suess, A.; Grosse, W. (Bayerische Landesanstalt fuer Bodenkulture, Pflanzenbau und Pflanzenschutz, Munich (West Germany). Abt. Strahlennutzung). Dec. 1968. 42p. (In German). Dep.

Experiments were made with several agricultural plants to study the influence of a seed irradiation with doses from 1 to 100 R on plant growth. A radiation-induced stimulation at different stages was found. The stimulation by radiation is induced by physiological reactions; therefore many changes can be observed. The stimulation effect can be influenced by the doses, the plant variety, and the growing conditions. Significant results were observed in germination, youth development, and at harvest. The uptake of nutrient elements and some enzyme-systems were influenced by irradiation. With potatoes, variety Maritta, an after-year effect was found in starch and tuber yield. (auth)

22434 (CONF-670649–8) VARIATIONS IN THE DEVELOPMENT OF DIFFERENT VEGETABLE SPECIES EXPOSED TO IRRADIATION. Gomez del Campo, C.; Casas-Becilla, M.; Martinez, M. (Instituto Nacional de Investigaciones Agronomicas, Madrid (Spain)). [1965]. 8p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

When seeds are irradiated with acute doses of γ rays, there are cases in which up to 1 Mrad is necessary to inhibit germination. The dose necessary to obtain this effect does not appear to have any correlation with the dose necessary to inhibit further development. In crucifers there is a large number of species whose LD_{50} exceeds 100 krads, but such radioresistance is not so evident when seedlings are irradiated. With increasing doses of chronic γ irradiation, a significant reduction of the size of sunflower plants is obtained, but there is an increase in the ramification frequency. At irradiations over 100 rads/day morphogenetic changes are observed in leaves. The fertility of the plants decreases significantly with irradiations of 65 rads/day. The number of folioles per leaf in the pea decreases in plants receiving only 50 rads/day. A case of total sexual reversion in a masculine plant of cucurbitaceous Ecballium elaterium Rich. var. dioicum was observed after exposure to thermal neutrons at 25 Krads on dry seeds. In the corresponding phylotactic map of the altered shoot, the female flowers are distributed almost exactly on a 180° sector. Because of its sector character, the reversion is probably of genetic origin. The pattern of the inflorescence continues to be the characteristic of the masculine plants of this variety. (tr-auth)

22435 EFFECT OF INCREASED OXYGEN PRESSURE ON THE RADIATION INJURY OF WHEAT GRAINS. Nor-Arevyan, N. G. (Agricultural Inst., Erevan). Biol. Zh. Arm., 21: No. 12, 93-5(Dec. 1968). (In Russian).

The oxygen effect, i.e., the increase of the partial pressure of oxygen resulting from the exposure of an organism to ionizing radiation, was investigated within a wide range of pressures. Grains of the Artashati-22 species of wheat were exposed to x radiation in the kiloroentgen range, then allowed to germinate. The effects of the following oxygen partial pressures on the growth dynamics were studied: 0 (1 atmosphere of nitrogen); 0.2 (air); 1.0, and 7.5 atmospheres. It was found that exposure to 45 kR stopped the growth and ultimately killed the plant. The increased oxygen or nitrogen pressure, applied for one day, did not affect the development of the unirradiated grains. The effect of radiation was found to increase with increasing oxygen pressure and increase of the dose enhanced the injurious effect of oxygen. (TTT)

22436 EFFECTS OF GAMMA RADIATION ON JUVENILE AND MATURE CUTTINGS OF QUAKING ASPEN. Stairs, G. R.; Jeffers, R. M. Forest Sci., 13: 240-5(Sept. 1967). (NYO-3571-3).

The radiation treatments utilized (^{60}Co γ) did not increase the rooting response of mature cuttings of Populus tremuloides Michx.; in juvenile material the treatment generally resulted in lowered growth rate and rooting ability. A comparison of rooting abilities was made between juvenile shoots that were directly irradiated with shoots obtained from irradiated root pieces. A significant difference in response was obtained between the two groups at intermediate levels of exposure, although the lethal level was similar for both. (auth)

22437 EFFECTS OF BLUE LIGHT ON THE SURVIVAL OF UV-IRRADIATED FERN GAMETOPHYTIC CELLS. Kato, Yukio (Nagoya Univ., Japan). Cytologia (Tokyo), 32: 519-23(Dec. 1968).

The survival pattern of fern protonemata resulting from uv exposure is controlled by post-illumination of visible light. A favorable effect of blue light on the survival of Pteris vittata irradiated by uv was demonstrated. (NSA of Japan)

22438 FREE RADICAL REACTIONS MODIFY CELLULAR DAMAGE. Dodd, N. J. F.; Ebert, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature (London), 221: 1245-6(Mar. 29, 1969).

It was found that changes in the ESR spectra of irradiated cell contents and the survival of irradiated fern spores showed an important correlation. Whole spores of Osmunda regalis were used in the survival studies described, and ESR measurements were made on the dried cell contents. Doses for ESR observations were of the order of 500 kR and those for survival experiments varied from 1 to 10 kR, given at 200 kR/min, and 3 kR/min, respectively. In survival experiments the spores were soaked in deoxygenated water 4 hr after irradiation to end further radical reaction, before culturing and scoring. Experimental results are tabulated and discussed. Irradiations were made in O$_2$, N$_2$, and NO (survival experiments). The ESR signals could be ascribed to five different radical groups. There was good qualitative agreement between radiation damage and ESR observations, although reaction rates measured by ESR were slower than those found biologically, suggesting that the radical groups are heterogeneous. Evidence was found that the potential for oxygen enhancement does not reside only in the initially produced species but can be handed on to daughter species. The results were similar to those reported for seeds, but differed from those for dried bacterial spores in that no sensitization was observed when NO was present during irradiation, and in that the presence of O$_2$ during irradiation produced no more damage than O$_2$ post-treatment. (UK)

Radiation Effects on Microorganisms

Refer also to abstracts 22253 and 22262–22264.

22439 (AEC-tr-6944, pp 710-12) CHANGES OCCURRING IN THE SKIN AUTOFLORA OF THE RAT FOLLOWING THE INCORPORATION OF THORIUM. Kuz'mina, T. D.; Kendysh, I. N. Translated from pp 564-6 of Raspredelenie i Biologicheskoe Deistvie Radioaktivnykh Izotopov, Atomizdat, Moscow, 1966.

The effects of thorium on the phagocytic function of the reticuloendothelial system of rats were studied. Thorium nitrate was administered in a single dose intratracheally (10 mg/kg) or perorally (100 mg/kg). Skin autoflora were determined by the agar imprint method and phagocytic activity by the rate of elimination from the blood of intravenously injected colloidal ^{198}Au. The animals treated with thorium by either route showed an increase in skin autoflora that was evident 24 hours after treatment and continued until a return to normal levels around the 200th day. The phagocytic activity in the rats treated with thorium was retarded as indicated by the half-life of ^{198}Au in their blood. (M.M.B.)

22440 REGULATION OF BIOSYNTHESIS OF SECONDARY METABOLITES. XI. INDUCTION OF VARIANTS IN STREPTOMYCES AUREOFACIENS AND THE SPECIFICITY OF MUTAGENS. Mracek, M.; Blumauerova, Margita; Paleckova, Frantiska; Hostalek, Z. (Research Inst. of Antibiotics and Biotransformations, Roztoky, Czech. Inst. of Microbiology, Prague). Mutat. Res., 7: 19-24(Jan.-Feb. 1969).

Three physical mutagens (γ radiation, uv irradiation and x rays), six chemical mutagens (N-methyl-N-nitroso-N′-nitroguanidine, nitrosomethylurea, ethyl methanesulphonate, nitrous acid, hydroxylamine and formaldehyde) and a combination of N-mustard and uv irradiation were tested for their ability to produce variants of Streptomyces aureofaciens having a modified morphology or pigmentation. Nitrosomethylurea and N-methyl-N-nitroso-N′-nitroguanidine were the most effective. The chemical mutagens differ with regard to their action: the alkylating agents cause variants with changes in spore color, but formaldehyde and hydroxylamine have no effect on the pigmentation. The lethal effect of the combined treatment of N-mustard in a sublethal dose and uv irradiation was smaller than the effect of uv irradiation only, but on the other hand the mutagenic effect of the same combination was greater. (auth)

22441 CATALASE ACTIVITY IN RADIORESISTANT AND RADIOSENSITIVE STRAINS OF ESCHERICHIA COLI B. Ang, Oezdem; Hartmann, Dieter; Schmidt, Bernhard (Freie Univ., Berlin). Zentralbl. Bakteriol. Parasitenk., Abt. I, Orig., 207: 19-27(1968). (In German).

The catalase activity of four strains of E. coli, including types B, B/r, B$_{S-1}$, and B$_{S-2}$ was measured as a function of growth rate to evaluate possible differences between radioresistant and radiosensitive strains. The maximum enzyme activities appeared in all four strains at the end of the logarithmic growth phase. There was no direct relation between the catalase activities measured in any of the strains and their radiosensitivities, although the enzyme activities measured varied between strains. (BBB)

22442 CORRELATION BETWEEN THE PHYSIOLOGICAL STATE OF BACTERIA AND THE RADIOPROTECTIVE EFFECTIVENESS OF CYSTEINE. Nagy, Zs.; Hernadi, F.; Kovacs, P.; Valyi-Nagy, T. (Univ. Medical School, Debrecen, Hungary). Arch. Mikrobiol., 61: 327-34(1968).

Escherichia coli 15 T$^-$ cells were cultured in the presence of cysteine, then removed and subjected to x irradiation (doses up to 15 KR) in cysteine-free buffer. The radiosensitivity was found to decrease in inverse ratio to the concentration of cysteine. This phenomenon occurred only with log-phase cells, while the radiosensitivity of stat-phase bacteria remained unchanged. This phenomenon was also studied by ^{35}S-cysteine. The extent and distribution of cysteine incorporation into the fractions of log-phase cells were found to differ from those occurring in the fractions of stat-phase cells. For the radioprotective effect of cysteine described, two different explanations are proposed: the radioresistance induced by cysteine presupposes an active metabolic state of the cells, which may correlate with the induction of the repair systems; the cysteine incorporated by the cells provides a radioprotective effect; hence only the radiosensitivity of long-phase cells decreases, while that of the stationary phase cells remains unchanged owing to their inability to incorporate cysteine in an amount rendering them effective radioprotectors. (BBB)

22443 REACTIVATION OF PHOTODYNAMICALLY INACTIVATED LAMBDA PHAGES. Geissler, Erhard (Univ., Rostock, Ger.). Mol. Gen. Genet., 103: 233-7(Dec. 31, 1968).

UV-irradiated λc phages show a lower survival when plated on rec$^-$-cells as compared to rec$^+$-cells. Photodynamically inactivated λc phages show the lowest survival on hcr$^-$; rec$^-$-cells. The rec-functions do not influence the repair of uv- or photodynamically induced lesions in T1 phages. (auth)

22444 QUANTUM YIELDS FOR INACTIVATION OF TOBACCO MOSAIC VIRUS NUCLEIC ACID BY ULTRAVIOLET RADIATION (254 nm). Evans, N. A.; McLaren, A. D. (Univ. of California, Berkeley). J. Gen. Virol., 4: 55-53(Jan. 1969).

Measurements were made of the quantum yield for uv inactivation of tobacco mosaic virus (TMV) RNA as a function of concentration during irradiation and the amount of photoreactivation of irradiated TMV–RNA under fixed conditions. Data are also reported on the influence of buffer ion concentration (phosphate) on quantum yields and the influence of various light sources on amounts of photoreactivation of uv-irradiated TMV–RNA. Irradiations of stirred solutions of TMV–RNA, in potassium phosphate buffer (pH 7) or in water, were made with a low-pressure mercury lamp (Hanovia Sc-2537) which emits predominantly light of wavelength 253.7 nm. It was shown that the quantum yield, under nonphotoreactivating conditions, for inactivation of the RNA by uv radiation is independent of the RNA concentration but varies appreciably with the ionic strength of the irradiation solvent, being ~3 times greater in water than in 0.1M potassium phosphate buffer. Photoreactivation of inactivated RNA is dependent on RNA concentration, ionic strength of solutions during irradiation, and on the light quality used for photoreactivation. These data were interpreted as evidence that pyrimidine hydrate is a lethal lesion at least in RNA irradiated at low ionic strength. (BBB)

22445 ANALYSIS OF THE GROWTH CYCLE OF MYCOPLASMA ORALE BY SYNCHRONIZED DIVISION AND BY ULTRAVIOLET IRRADIATION. Furness, Geoffrey (New Jersey Coll. of Medicine and Dentistry, Jersey City). J. Infect. Dis., 118: 436-42(Oct. 1968).

Results presented indicate that Mycoplasma orale has a comparable growth cycle, the elementary bodies dividing by binary fission to form aggregates of two elementary bodies in broth and colonies on agar. The mycoplasma suspension on an agar plate was irradiated for 5 to 25 sec with uv light of wavelength 2537 Å and an intensity of 220 μw/cm^2/sec. Elementary bodies were inactivated exponentially by uv light with 99% being killed in 9.6 sec at the intensity used. The rate of inactivation was dependent on the intensity of the irradiation but independent of the concentration of the cells. Broth cultures were not inactivated exponentially, confirming that they contain clusters of elementary bodies. (TSS) (BBB)

22446 RADIORESISTANCE OF BACTERIA AS A FUNCTION OF p-HYDROXYMERCURIBENZOATE BINDING. Bruce, A. K.; Sansone, P. A.; MacVittie, T. J. (State Univ. of New York, Buffalo). Radiat. Res., 38: 95-108(Apr. 1969).

A linear relationship exists between the LD$_{90}$ of bacteria and the binding of p-hydroxymercuribenzoate (HMB). The radiation response of twelve strains representing four families and eight genera exhibited a range of LD$_{90}$ from 4.5 to 450 kR with a variety of shapes. HMB binding varied from 2.7 × 10^{-19} to 4.6 × 10^{-17} mole per colony-forming unit (CFU). A similar relationship exists between the D$_0$ and the HMB binding per cell. This agent saturates its binding sites (sulfhydryl groups) in the intact cell in about 30 minutes and is located in the cell surface and in soluble intracellular fractions of both high and low molecular weight. Exceptions to the relationship include Escherichia coli Bs-$_1$ and mutants of Micrococcus radiodurans, which have a lower survival than their HMB binding would predict. Of the four strains of E. coli tested, all bind approximately the same amount of HMB; while their LD$_{90}$'s vary from 4.5 to 37 kR. Similarly, the mutants of M. radiodurans all contain the same sulfhydryl content, while their LD$_{90}$'s vary from 105 to 735 kR (12). These data suggest that radioresistance is determined primarily by the presence of a functional repair system in the cells. The radioresistance of this repair system is in turn determined by the sulfhydryl content of the cell. (auth)

Radiosterilization and Radiopreservation

22447 EXTENDING THE STORABILITY OF STRAWBERRIES BY MEANS OF IONIZING IRRADIATION. Farkas, J.; Kiss, I. Konzerv. Paprikaipar, No. 2, 63-8(1967). (In Hungarian).

The effect of ionizing irradiation (x and γ irradiations) on the storability of several varieties of strawberries was examined. The samples were stored in open or covered Petri dishes or in perforated polyethylene bags at 8 to 10°C. The color of the fruits and the quantity of the dyes soluble in hydrochloric acid methyl alcohol showed no significant difference when compared to the controls after irradiation with 400 kRad. After 300 kRad no strange odor or taste was noticed but the intensity of the characteristic strawberry aroma was somewhat less pronounced immediately after irradiation than that of the unirradiated fruit. The storability of the various strawberries differed according to the variety and physiological condition of the irradiated samples. On the average fruits irradiated with 200 kRad were 1.5 to three times more storable, but higher—300 to 400 kRad—doses had no significant effect on storage. Rotting and mildew growth appeared with delay on fruits kept in covered Petri dishes or in polyethylene foils. (Hung. Tech. Abstr.)

22448 EXTENDING THE STORAGE LIFE OF INITIALLY SPROUTED POTATO TUBERS BY GAMMA RADIATION (THE SUMMER CROP). Zidan, E. Abdel-al (Alexandria Univ., Egypt. Atomic Energy Establishment, Inshas, Egypt). Food Irradiat., 9: No. 1-2, 14-17(July-Dec., 1968).

Growers often complain that some of their recently harvested summer potato crop shows sprouting either in the field or right after digging. The effect of different doses of gamma radiation from a cobalt-60 source on tubers that showed recent sprout development was tested. Tubers of an Alpha variety were exposed to 0, 8,000, 10,000, 12,000, and 14,000 R of radiation at Inshas Atomic Energy Establishment. Each treatment consisted of 50 tubers and 4 replications. Tubers were stored after exposure for 6 months. The fresh weight, length and diameter of the sprouts decreased considerably as the radiation dose increased. Lower doses of gamma radiation favored new sprout development. It was concluded that in order to retard, check, and prevent new sprout development, sprouted potatoes should be exposed to 14,000 R of gamma radiation. (auth) (C.O.)

22449 THE EFFECTS OF GAMMA RAYS ON VARIETIES OF VEGETABLES CULTIVATED IN VENEZUELA. Revetti, L. M. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Food Irradiat., 9: No. 1-2, 2-7(July-Dec. 1968).

The effect of ^{60}Co γ radiation on the shelf life of various varieties of peppers and tomatoes was investigated. An increase of six days in the shelf life of the hot variety of peppers treated with 350 krad was noted; at 500 krad, shelf life was 7 days shorter than that of the control. The shelf life of the sweet variety of peppers was extended 3 days at 100 krad. Irradiated samples of tomatoes showed no difference in ripening compared to the controls; a fairly promising result was found at 100 krad. It was concluded that radiation preservation of these vegetables may be economical but that further investigation is needed to establish the most promising methods. (C.O.)

22450 PRESERVATION OF MANGOES (MAGNIFERA INDICA L.) BY GAMMA RADIATION. Mumtaz, Ali; Farooqi, W. A.; Amir, Muhammed (Atomic Energy Centre, Lahore). Food Irradiat., No. 1-2, 8-13(July-Dec., 1968).

The effect of irradiation by ^{60}Co gamma rays on induction of ripening delay in mangoes was studied. Ripening of hard green mangoes could be delayed by gamma radiation; best results were obtained at a dose of 30 krad when storage was at room temperature (25 ± 2°C). There was also no significant loss of the nutritive constituents in irradiated mangoes. Organoleptic evaluation showed that the irradiated samples (up to 30 krad) were still acceptable after 2 weeks of storage whereas the control ones had completely shrivelled and decayed. (auth)

22451 WHOLESOMENESS PROBLEMS RELATED TO THE USE OF IONIZING RADIATION ON FOOD PRODUCTS. Uralova, Minna; Durcek, Karol (Inst. of Health, Bratislava). Prum. Potravin, 18: 255-6(1967). (In Czech).

The effects of ionizing radiation on foods and its use to increase the shelflife of food products are briefly reviewed. Both machine (linear accelerator, Van de Graaff, x-ray) and radioisotope (^{137}Cs, ^{60}Co, ^{24}Na) sources of ionizing radiation are used for food preservation. The effects of radiation doses, from 0.01 to 6 Mrads, on organisms in food and on pests of foods are tabulated. For example, 0.01 to 0.05 Mrad sexually sterilizes insects while 4 to 6 Mrads destroys the microorganisms in meats. The foods themselves are also affected. For example, high radiation doses produce mercaptans in proteins. Changes induced in fats and carbohydrates are also briefly summarized. Vitamins in the foods are affected by pasteurizing as well as sterilizing doses, the action being partially through the H_2O_2 produced in radiolysis. (TTT)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 22620 and 23872.

22452 LONG TERM ECONOMIC CONSIDERATIONS IN THE INCREASED UTILIZATION OF BERYLLIUM METAL. Krivsky, W. A. (Continental Copper and Steel Industry, Inc., New York). Met. Soc. Conf., 34: Pt. 1, 45-56(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

The extent of the utilization of Be is likely to be the result of its technical commercial utility, its availability, and its cost. In addition to these considerations, beryllium usage will also depend upon the proper understanding and control of its toxicity. Progress has been made in this material's technical and commercial utility, its availability, and its toxicity problem. Estimates are included concerning the effects of developments in extractive metallurgy on the selling price of beryllium products. These projections indicate that a selling price of the order of magnitude of $15 is realistic for powder at volumes roughly ten times greater than present existing plant capacities. Billets ready for machining, forging, or sheet production should be available under the same conditions at approximately $20/pound. Beryllium sheet can ultimately reach prices of $25 to $30 per square foot. (auth)

22453 BERYLLIUM RECOVERY FROM SPOR MOUNTAIN, UTAH, ORE. Bridges, D. W.; Dannenberg, R. O.; Clemmons, B. H. (Bureau of Mines, Salt Lake City). Met. Soc. Conf., 34: Pt. 1, 69-96(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

A laboratory scale acid leach-solvent extraction technique has enabled recovery of over 80% of the beryllium present in Spor Mountain, Utah, ore in a 99% beryllia product. Processing comprised H_2SO_4 leaching, countercurrent decantation (CCD), iron(III) reduction by NaHS, di-2-ethylhexyl phosphoric acid (EHPA) solvent extraction, NaOH stripping, hydrolysis of Na_2BeO_2 strip solution to form $Be(OH)_2$, and filtration and calcination of $Be(OH)_2$ to form BeO. Reagent consumption, in pounds per pound of BeO recovered, averaged 79 H_2SO_4, 13.2 NaOH, 2.7 NaHS, 0.25 kerosine, 0.07 polyacrylate flocculant, 0.03 EHPA, and 0.007 isodecanol (IDA). Owing to the clayey nature of the ore, leaching was effected with 600 lb of H_2SO_4 per ton of ore at 35% solids and 65°C for 24 hr. Moreover, subsequent efficient CCD washing required nearly 4 tons of water per ton of ore, unless the ore was roasted at 500°C before leaching or an alternative liquid-solids separation method was used. Best overall countercurrent solvent extraction was effected at 45°C, using a specific power input of 20 hp per 1000 gal of dispersed liquids, a retention time of 17 min in each of seven mixer-settlers, a pH 2 aqueous feed, and an organic feed that was 0.25$\underline{N}$ EHPA dissolved in kerosine containing 2% of IDA. (auth)

22454 OXIDATION-RESISTANT BERYLLIUM ALLOYS. Darras, Raymond (to Commissariat a l'Energy Atomique). British Patent 1,146,452. Mar. 26, 1969. Priority date July 11, 1966, France.

A Be-base alloy containing between 0.05 and 3 wt % Ca and/or Mg between 0.1 and 3 wt % Cu is described. The alloy is particularly applicable to use as sheathing material for nuclear fuel elements because of its resistance to oxidation in moist CO_2 under pressure and its good mechanical strength. (B.L.M.)

22455 SCANNING ELECTRON MICROSCOPE: ITS OPERATION AND USE. Johari, Om (Illinois Inst. of Tech, Chicago). Metal Progr., 94: No. 2, 147-50(Aug. 1968).

Intricate details of rough surfaces, e.g., those of fractures, metal powders, and machined stock were followed by a scanning electron beam of high intensity. The resulting image was displayed on a cathode ray tube and was easily photographed. (auth)

22456 NEW METHODS POINT THE WAY IN METALLOGRAPHY. Gray, Robert J. (Oak Ridge National Lab., Tenn.). Metal Progr., 94: No. 2, 133-8; 142-3(Aug. 1968).

Developments in the preparation and examination of metallographic specimens are discussed. Techniques and instrumentation for defining and determining the microstructure of metals are described. Procedures for quantitative evaluation of microstructural characteristics are given. (G.M.C.)

22457 SOLUTIONS TO SOME MATERIAL PROBLEMS IN THE NUCLEAR POWER INDUSTRY. Edstroem, John Olof (Sandvik Steel Works, Sandviken, Sweden). 24p. of International Nuclear Power Day. Sandviken, Sweden, Sandvik Steel Works, 1968.

From Conference on International Nuclear Power Day, Sandviken, Sweden. See CONF-681124.

The selection and performance of materials for the nuclear power industry are discussed with specific reference to: canning materials for fuels of water-cooled reactors, such as nickel alloys, stainless steels, and zirconium alloys; nickel alloy and stainless steels for heat exchanger tubes; cladding materials for reactor pressure vessels; and Cr–Ni steels and nickel-base alloys for composite tubing for control rod inlets. (L.C.L.)

Corrosion and Erosion

Refer also to abstracts 22595 and 23890.

22458 (AI-AEC-12744, pp 79-92) MECHANICAL PROPERTIES IN SODIUM. Atkins, D. F. (Atomics International, Canoga Park, Calif.).

Data on stress-rupture of Types 304 and 316 stainless steels in helium or sodium are presented. Stress-rupture properties of Type 304 stainless steel are reported for helium at 1200 to 1400°F, for sodium at 900 to 1400°F, and for copper-contaminated sodium at 1300°F. Data on stress-rupture of Type 316 stainless steel at 1200°F in sodium are included. (J.C.W.)

22459 (AI-AEC-12744, pp 93-116) DYNAMIC LOOP OPERATION. Shively, J. H. (Atomics International, Canoga Park, Calif.).

Test results are tabulated for operation of high flux heat assemblies. Two compatibility tests were conducted in support of heater improvement. Data and metallographic displays are included for heater post mortems. Experiments devoted to heater electrode improvement are discussed. Data are also included on stress-rupture of helium-injected tubes of Types 304 and 316 stainless steel. Mass transfer by 1200° Na of species from Type 304 stainless steel are being determined by activation analysis. (J.R.D.)

22460 (BAW-3765-7) CORROSION AND HYDRIDING OF ZIRCALOY. Task 1 Final Report. CORROSION AND HYDRIDING OF ZIRCALOY UNDER HEAT TRANSFER CONDITIONS. Rubright, M. M.; Koch, D. W.; Ferguson, K. M. (Babcock and Wilcox Co., Alliance, Ohio. Research Center). Jan. 1969. Contract AT(30-1)-3765. 149p. (EURAEC-2016). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

The corrosion and hydriding characteristics of Zircaloy-4 under operating conditions simulating those expected in advanced water reactors were determined. A number of 0.420-inch-diameter tubular Zircaloy-4 and Zircaloy-2 specimens were exposed to 640°F water in a high pressure dynamic loop. The coolant pressure was 2250 psi and velocity past the specimen was about 13 fps. Special heaters inserted in the specimens gave surface heat fluxes of 600,000 Btu/hr-ft^2 over a 6-inch section. It was found that the corrosion rates of Zircaloy under heat transfer and isothermal conditions are essentially the same and that more hydrogen is absorbed under heat transfer conditions than under isothermal conditions. The presence of dissolved hydrogen in the coolant in concentrations of 20 to 40 cc per liter does not affect the hydrogen absorption rate and the presence of chemical shim control solids do not affect the corrosion rate or the hydrogen absorption rate under short-term conditions. Also, shim control chemicals do not concentrate on the cladding under the short-term conditions. (J.R.D.)

22461 (BNWL-CC-1646) CORROSION OF STAINLESS STEEL IN SOLUTIONS OF CERIUM(IV)–NITRIC ACID. Lerch, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1, 1968. Contract AT(45-1)-1830. 10p. Dep. CFSTI.

Type 304 stainless steel was found to corrode quite rapidly in nitric acid solutions containing cerium(IV) nitrate. Dissolution rates of the stainless steel increased with increases in total cerium concentration, nitric acid concentration, rate of cerium(IV) generation, and temperature. The maximum dissolution rate was 3714 mg/cm^2/month (~2.26 in./yr) for dissolution of stainless steel in 2.0$\underline{M}$ nitric acid–0.10$\underline{M}$ cerium(IV) at 50°C. (The normal dissolution rate for 304 stainless steel in 2$\underline{M}$ nitric acid at 50°C is <0.17 mg/cm^2/month.) The rate of 3714 mg/cm^2/month is sufficiently high to rule out stainless steel as a material of construction for use with cerium(IV)–nitric acid solutions unless a corrosion inhibitor can be found; however, the rate is probably too low to make the process attractive for fuel decladding. (auth)

22462 (BNWL-SA-2080) EROSION–CORROSION OF ALUMINUM IN HIGH VELOCITY WATER. Jones, D. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [nd]. 7p. (CONF-690304-2). Dep. CFSTI.

From 25th Annual Conference of the National Association of Corrosion Engineers, Houston, Tex.

Experiments were performed to examine the effects of high temperature high velocity water on the corrosion and erosion of aluminum specimens. This simulates conditions for aluminum clad reactor fuel elements exposed to cooling water. The construction and operation of the laboratory apparatus is described. A single pass of high velocity hot water was used. In situ electrochemical measurements were made. It is suggested that erosion occurs primarily in the oxide film, thinning the film and thereby accelerating corrosion. This process occurs more rapidly at high temperatures and with an increasing degree of solution impurities. Deep surface grooving is assumed to be the result of hydraulic action on existing surface imperfections. (L.C.L.)

22463 (CEA-R-3638) PROTECTION OF URANIUM BY METALLIC COATINGS. Baque, Pierre; Koch, Philippe; Dominget, Raymond; Darras, Raymond (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1968. 35p. (In French). Dep.

Inhibiting or limiting, by means of protective metallic coatings, the oxidation of uranium by carbon dioxide at high temperature was investigated. Surface films containing intermetallic compounds or solid solutions of uranium with aluminum, zirconium, copper, niobium, nickel or chromium were formed. The processes most recommended for film formation were direct diffusion starting from a thin sheet or tube, vacuum deposition, and immersion in a molten bath of suitable composition. The conditions for preparing these coatings were optimized as a function of the protective effect obtained in carbon dioxide at 450 or at 500°C. Only the aluminum and zirconium based coatings were satisfactory since they could lead to a reduction in the oxidation rate of uranium by a factor of 5 to 10; they made it possible to avoid or to reduce to a very large extent the liberation of powdered oxide. Furthermore, the coatings produced generally gave the uranium good protection against atmospheric corrosion. (auth)

22464 (GEAP-5743) SPECIFIC ZIRCONIUM ALLOY DESIGN PROGRAM. Quarterly Progress Report Nos. 22 and 23. Mehner, A. S.; Klepfer, H. H.; Pickett, A. E. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Jan. 1969. Contract AT(04-3)-189. 30p. (EURAEC-2096). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A Zr + 2.0 at. % Cr + 0.16 at. % Fe alloy (Zr-Cr) is being evaluated as nuclear fuel cladding. Zr-Cr alloy-clad fuel rods are being irradiated in the Consumers Big Rock Point reactor to a target exposure of 20,000 MWd/tU. The rate of fuel burnup has been approximately 800 MWd/tU (average) per month of full-power operation. The long-term, out-of-pile, loop corrosion tests have been satisfactorily completed. The Zr-Cr samples were tested in a loop which simulated a boiling-water environment including heat transfer. The samples accumulated approximately 7,800 hours of exposure. During the June–July 1968 reactor outage, the pool examination of the B-1 assembly indicated that the Zr-Cr and Zr-2 test rods were performing satisfactorily after 8,000 MWd/tU bundle average exposure. Nine test fuel rods and two dummy rods were removed from the bundle. The post-irradiation examination of these rods has been initiated. The assembly was reconstituted and the irradiation continued. As of December 31, 1968, the Zr-Cr rods inserted in June 1967 have accumulated an average exposure of 12,000 MWd/tU, and the replacement rods inserted in June 1968 have accumulated an average exposure of 4,300 MWd/tU. (auth)

22465 (IITRI-578-P-29-32) RESEARCH ON ZIRCALOY BRAZE ALLOY DEVELOPMENT. [Quarterly Report], October 1–December 31, 1968. (Illinois Inst. of Tech., Chicago, Ill.). Jan. 17, 1969. Contract AT(11-1)-578. 21p. (EURAEC-2086). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The fourth and final exposure period in the corrosion loop with lithium hydroxide for pH control was completed, and the specimens have been received for examination. Specimens removed from the third hydrodynamic exposure period have been fully evaluated for corrosion and mechanical properties. In view of the program timing, a decision has been made to select candidate alloys for exposure in the corrosion loop with ammonium hydroxide for pH control, on the basis of the completed corrosion and tensile evaluations. Seventeen alloys have been chosen, and 10 specimens are being prepared with each alloy. A satisfying number of alloys have promising corrosion and mechanical strength data. The selection is, however, subjective and anomalous and results have not been used for the basis of candidate alloy rejection. A full examination of specimens exposed for the fourth period will be made shortly and will clarify the final alloy selection. Adjustments will be made to the alloy selection, where necessary, for inclusion in the final hydrodynamic loop test. (auth)

22466 (ORNL-TM-2490) COMPATIBILITY OF HASTELLOY N AND CROLOY 9M WITH NaBF$_4$–NaF–KBF$_4$ (90-4-6 mole %) FLUOROBORATE SALT. Koger, J. W.; Litman, A. P. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26). 41p. Dep. CFSTI.

The compatibility of a relatively impure (>3000 ppM impurities) fluoroborate salt, NaBF$_4$–NaF–KBF$_4$ (90-4-6 mole %), with Hastelloy N and Croloy 9M was evaluated in natural circulation loops operating at a maximum temperature of 605°C with a temperature difference of 145°C. The Croloy 9M loop (NCL-12) was completely plugged after 1440 hr of operation and the Hastelloy N loop (NCL-10) was three-quarters plugged after 8760 hr (one year) of operation. All major alloying elements of the container materials mass transferred during operation as the result of nonselective attack by virtue of the initial oxygen and water contamination of the salt. Saturation concentrations of 700 ppM Fe and 470 ppM Cr were determined for the fluoroborate salt at 460°C. The mechanism of corrosion of the system is as follows. Initially, metal fluoride compounds that are soluble in the salt are formed in the hot leg. The reverse reaction occurs in the cold leg and causes the metal to deposit and to diffuse into the cold leg. This continues until an equilibrium concentration of one or more metal fluorides is reached in the salt at the cold-leg temperature and these compounds start depositing (e.g., NCL-10) or, the equilibrium constant of the reaction changes so much with temperature that the pure metal is deposited (e.g., NCL-12). (auth)

22467 (RFP-1260) EVALUATION OF COATINGS FOR LITHIUM. Pitts, Sam H. Jr. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Feb. 27, 1969. Contract AT(29-1)-1106. 6p. Dep. CFSTI.

Coatings and coating techniques to protect lithium parts from atmospheric corrosion were investigated. These included organic coatings applied by various methods and conversion-replacement type coatings formed in solutions. An unsuccessful attempt was made to put a protective coating on lithium by conversion-replacement type surface reactions. Failure was due primarily to the lithium-water reaction, which took place during the reaction. Plastic coatings were more successful, but an absolute water vapor barrier was not obtained. The best coatings evaluated were the vapor-deposited poly-p-xylylenes. Results indicated that it is not feasible to protect lithium from atmospheric moisture for long periods with organic coatings or by the formation of conversion or replacement type surfaces. Organic coatings do have potential in protecting lithium for limited periods of times. This is especially true for atmospheres, such as room air, that have less than a 100% relative humidity. (auth)

22468 CORROSION BEHAVIOR OF NONFERROUS ALLOY FEEDWATER-HEATER MATERIALS IN NEUTRAL WATER WITH LOW OXYGEN CONTENTS. Brush, E. G.; Pearl, W. L. (General Electric Co., San Jose, Calif.). Corrosion, 25: 99-105(Mar. 1969).

Copper bearing alloys are widely used in steam generation feedwater heaters, and although corrosion rates are minimal, copper corrosion product release has caused some undesirable deposition in BWR plants. Limited data exist for prediction of corrosion product input to high pH, low oxygen fossil plant feedwater, and essentially no data are available for predicting input to BWR type operation of neutral pH and low oxygen feedwater. The copper problem was resolved in later BWR plants by changing to stainless steel feedwater heaters. A test program was instituted to study copper alloy corrosion product release behavior in BWR feedwater conditions of flowing, neutral pH water, containing less than 10 ppB oxygen at 150 to 400°F. The alloys examined were Admiralty brass, 90-10 copper nickel, 70-30 copper nickel, 70-30 copper nickel iron-modified and Monel alloy. Corrosion product release was determined gravimetrically on coupons, made from tubing furnished to ASTM feedwater heater specifications, as a function of time and temperature in a recirculating dynamic facility. Essentially 100% of the corrosion products generated on all alloys tested were released to the feedwater at all temperatures, with the release rates being invariant in time. The release rates of Monel alloy varied from 1 mg/dm^2 month at 150°F to 80 mg/dm^2 month at 400°F. Those of the four other alloys were low and nearly identical, ranging from 1 to 3 mg/dm^2 month at 150°F to 8 to 12 mg/dm^2 month at 400°F. (auth)

22469 LIQUIDUS CURVES AND CORROSION OF Fe, Ti, Zr, AND Cu IN LIQUID Bi–Pb ALLOYS. Weeks, J. R.; Romano, A. J.

(Brookhaven National Lab., Upton, N. Y.). Corrosion, 25: 131-6(Mar. 1969).

Liquidus curves were measured of Fe in Pb, Fe in Pb–Bi alloys ranging from 39.3 to 93.5% Bi, Cu in Pb–Bi alloys around the eutectic composition, and Ti and Zr in Pb–Bi alloys of approximately the eutectic composition. In all cases these solutes are less soluble in Pb or Pb–Bi alloys than in Bi. The Fe solubility decreases monotonically with increasing Pb concentration; the logarithm of the Fe solubility is approximately a linear function of the Pb concentration with slight positive deviations, expecially in Bi-rich alloys. The relative corrosion behavior of steels in Bi–Pb alloys at 650 to 500°C ΔT is estimated from the measured solubilities, and compared with the corrosion behavior of steels in these two liquids. Although the solubilities of Ti and Zr in Bi–Pb alloys are lower than in Bi, adequate amounts of these metals can be added to inhibit corrosion of steels in Pb–Bi systems and possibly also in liquid Pb systems. The heats of solution of Fe in Bi, Pb, and their alloys also increase monotonically from Bi to Pb. This behavior is interpreted in terms of the Alcock–Richardson model for dilute ternary solutions. (auth)

22470 THE ANODIC DISSOLUTION OF POLYCRYSTALLINE Be. Sheth, K. G.; Johnson, J. W.; James, W. J. (Univ. of Missouri, Rolla). Corros. Sci., 9: 135-44(Mar. 1969).

The effect of F^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, Li^+, Na^+, K^+, and Mg^{2+} on the anodic dissolution of polycrystalline Be at various c.d.s. was studied in aqueous solutions. The apparent (calculated) valency with which Be ions enter into solution was found to be relatively independent of c.d. but dependent on the nature and concentration of the solutions. The halide anions were found to cause the greatest decrease in the apparent valency. An anodic dissolution mechanism, involving local corrosion, disintegration, and the effect of ions is proposed to explain the results. (auth) (UK)

22471 CHEMICAL CONVERSION COATINGS RETARD CORROSION OF BERYLLIUM. Booker, J.; Stonehouse, A. J. (Brush Beryllium Co., Cleveland). Mater. Protect., 8: 43-7(Feb. 1969).

It was shown that chemical conversion coatings and low temperature enamels prevent corrosive attack on Be parts in environments which contain moisture, chloride, ions and/or high temperature oxidizers. Surface preparation and application methods are also discussed. By conversion coatings the corrosion of Be can be reduced drastically, if not eliminated completely. A double coating (combining a conversion coating with an enamel) eliminated corrosion of Be in humid atmospheres and salt spray. Chromate conversion coatings prevented the oxidation of Be at temperatures at least to 1700°F. Research in quality control procedures is needed to ensure the uniform application of conversion coatings. Beryllium has inherent corrosion resistance which can be lost locally but enhanced through coatings. (BBB)

22472 THE OXIDATION OF TANTALUM METAL IN CO_2 ATMOSPHERES. Richards, K. J. (Kennecott Copper Corp., Salt Lake City); Wadsworth, M. E. Met. Soc. Conf., 34: Pt. 1, 291-304(1968).

From Conference on High Refractory Metals, New York. See CONF-650227–(Pt.1).

The oxidation rates of tantalum metal in various partial pressures of CO_2 at 700 to 950°C were measured with a quartz spring thermobalance. Oxidation involved a surface-controlled reaction associated with the formation of a nonprotective scale of Ta_2O_5. Below about 720°C, there was a change in the rate-determining mechanism, and above 830°C the linear rate was preceded by a complex region of nonlinear oxidation behavior. The linear oxidation of tantalum has been explained quantitatively in terms of carbon dioxide adsorption, followed by a rate-controlling surface reaction. The enthalpy for chemisorption of CO_2 was determined to be −17.3 kcal/mole, and the surface-controlled reaction had an activation enthalpy of 40.4 kcal/mole. (auth)

22473 EFFECT OF MODULATED CURRENT ON ETCHING OF TANTALUM. Lakshminarasimhan, V.; Narasimhan, K. R.; Shenoi, B. A. (CECRI, Karaikudi, India). Denki Kagaku, 35: 18-24(1967).

Different wave forms of current were employed for the study of etching tantalum in non-aqueous electrolytes. The etch ratio is maximum with single phase half-wave rectified current. The water content in methanol is critical and the etch ratio decreases with increase in water concentration. The wt loss data are presented and the results are discussed. (Indian Sci. Abstr.)

22474 PARABOLIC OXIDATION KINETICS OF ALPHA-ZIRCONIUM. Madeyski, A.; Poulton, D. J.; Smeltzer, W. W. (McMaster Univ., Hamilton, Ont.). Acta Met., 17: 579-84 (May 1969).

The diffusivity of oxygen in the monoclinic zirconia scale formed on zirconium has been determined at 750, 850, 950°C by an oxygen-18 exchange technique. A comparison of these determinations to those determined for the self-diffusion of oxygen in monoclinic zirconia demonstrated that oxygen migration in the columnar structured scale occurred largely by short-circuit diffusion. A previously proposed two-phase diffusion model for concurrent growth of a superficial zirconia scale and oxygen solution in the metal accounts for parabolic oxidation kinetics insofar as the structure of the scale remains a time independent parameter. It was possible to demonstrate, by calculations from this model, that the oxygen concentration drop across the oxide scale was relatively small and of the order 4×10^{-2} g/cm^3 and that the magnitudes of the overall parabolic oxidation kinetics would be significantly decreased at temperatures less than 700°C if a zirconia scale exhibiting only lattice diffusion of oxygen could be formed on alpha-zirconium. (auth)

22475 KINETICS OF OXIDATION OF Zr–1 PERCENT Nb ALLOY IN PRESSURIZED STEAM AND AIR AT 400 TO 700°C. ElShanshoury, I. A.; Rudenko, V. A.; El-Dahshan, M. E.; Hammad, F. H. (Atomic Energy Establishment, Cairo). Corros. Sci., 9: 217-24(Apr. 1969).

The corrosion behavior of Zr–1% Nb in air and in steam was investigated in the temperature range 400 to 700°C. Two stages of corrosion were observed in air, i.e., an initial parabolic stage followed by a linear stage. In steam, three stages of corrosion were detected. The first stage was found to be parabolic, the second stage could not be described by either a parabolic or a linear law, while the third stage followed a linear relationship. Electron microscopic examination showed that the second stage in steam was associated with the formation of small regions having a structure different from that of the oxide film. Blade-like oxide crystals protruding from the surface were also noted. A model suggesting the diffusion of cation vacancies to the oxide surface is presented to explain these observations. (auth)(UK)

22476 OXIDATION OF IRON AT 950°C IN OXYGEN/WATER VAPOUR MIXTURES. Tuck, C. W.; Odgers, M.; Sachs, K. (GKN Group Research Centre, Wolverhampton, Eng.). Corros. Sci., 9: 271-85(Apr. 1969).

The presence of steam was found to accelerate the oxidation in oxygen of mild steel and two grades of pure iron of varying purity. In the case of the pure iron the effect was only found if the samples were taken up to the oxidation temperature in argon. In general, the effect was found to be greater on round test pieces than on flat rectangular pieces. Hydrogen and steam can accumulate in pores and enable the inward transport of oxygen to take place, but porosity was not observed in all cases where increased scaling occurred. It seems that the presence of steam enables a compact scale to maintain contact all over the test-piece surface, whereas contact is lost in the case of samples scaled in oxygen alone. This implies that the oxide acquires greater plasticity (ability to creep), possibly due to the incorporation of hydrogen in the lattice. It is shown that the results cannot be accounted for by accelerated diffusion of lattice vacancies within the oxide. (auth)(UK)

22477 RATE CONTROLLING PROCESSES DURING THE PRE-TRANSITION OXIDATION OF ZIRCONIUM ALLOYS. Cox, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 31: 48-66(May 1969).

The potentials developed across growing oxide films on zirconium alloys, and the current-voltage characteristics of these oxide films show that a simple treatment of the oxidation potential to give transport numbers for ions and electrons is not possible for these alloys. Many of the conditions for such a treatment to apply are not met. The shape of the current-voltage curves shows that the ionic current obeys the Tafel relationship, whereas the electronic current is best fitted by a Schottky emission process. The predicted effect of polarization during oxidation (predicted from the current-voltage curve) was observed for zirconium specimens. An anomaly in the current-voltage curves for Zircaloy-2 resulted in similar predictions being obeyed only for very thin films. The cause of the anomaly was not established but its occurrence was correlated with a sharp change in the oxidation potential. (auth)

22478 COMMENTS ON "AQUEOUS CORROSION OF THE ZIRCALOYS AT LOW TEMPERATURES." Cox, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 30: 351-2(Apr. 1969).

The conclusion that the most probable pre-transition oxidation behavior of Zircaloy-2 and -4 obeys a cubic rate law is disputed. The reproducible and pronounced inflection in the weight gain curves at around 10 mg/dm^2 which divide into at least two oxidation periods, and the oxidation curves beyond this inflection are fitted to a smooth curve which shows that the slopes of this curve vary from 0.286 (quartic not cubic) to 0.387. (F.S.)

22479 HIGH TEMPERATURE X-RAY INVESTIGATION OF PLUTONIUM OXIDATION. Terada, K.; Meisel, R. L.; Dringman, M. R. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Nucl. Mater., 30: 340-2(Apr. 1969).

Metal surfaces were studied by high vacuum x-ray diffraction during oxidation to determine if changes occur at 300 to 420°C. Results show that a change in oxide structure occurs in the temperature range where rate anomaly was reported. The section begins at about 250°C at a very low rate. In the 400°C region, the temperature of the rate of PuO formation is sufficiently rapid so that a film of PuO is always present adjacent to the metal. This could affect the entire oxidation rate. (F.S.)

Preparation and Fabrication

Refer also to abstracts 21873, 21901, 22534, 22550, and 22553.

22480 (BARC-328) HIGH-PURITY NIOBIUM THROUGH ALUMINOTHERMIC REDUCTION OF NIOBIUM PENTOXIDE. Gupta, C. K.; Jena, P. K. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 12p. Dep.

Massive niobium metal was obtained by aluminothermic reduction of Nb_2O_5 in a closed magnesia-lined mild steel vessel. The reaction was initiated by external heating of the bomb at about 450°C (outer wall temperature of the bomb) using a small amount of the trigger mixture of calcium and sulfur. The niobium metal button yield cleanly separated from the slag, was about 88% using 100 g of the oxide per run. The as-reduced metal obtained with a stoichiometric amount of the reductant was found to contain 2.82% of the Al and was very brittle. However, removal of aluminum and other impurities from the reduced metal was successfully achieved by nonconsumable arc melting in an argon atmosphere and electron-beam refining without much loss in niobium value. The purified niobium thus obtained has a hardness value of 100 DPH compared with 380 for the reduced one. The presence of very small amounts of impurities and easy workability of the metal (more than 95% reduction) without any intermediate annealing are strong supports in favor of the high purity. (auth)

22481 (NLCO-1033) A CONCEPTUAL CELL FOR ELECTROWINNING LIQUID URANIUM. Polson, C. E.; Kato, T. R.; Trapp, J. H. (National Lead Co. of Ohio, Cincinnati); Kesterke, D. G. (Bureau of Mines, Reno, Nev.); Rapp, R. A. (Ohio State Univ., Columbus. Dept. of Metallurgical Engineering). [1968]. 25p. (CONF-681204-2). Dep. CFSTI.

From Electrometallurgy and Electric Furnace Symposium, Cleveland, Ohio.

A production-scale cell is proposed for electrowinning liquid uranium from uranium dioxide feed in a molten fluoride electrolyte. The design is based on the development work of several investigators. Features of the design include a vertical cathode, a terraced, electrically floating hearth, isolation of the metal pool from the oxide feed, and provision for rapid removal of the molten metal. Problems of other researchers in achieving high current efficiencies and the importance in the cell design of feeding sufficient oxide to the anode area and of maintaining ample metal-to-anode spacing are analyzed. (auth)

22482 (ORNL-tr-1888) GROWTH OF METALLIC CRYSTALS BY THERMAL DECOMPOSITION OF HALIDES IN THE GAS PHASE. Gillardeau, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-Bib-93. 24p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 2020. (R.C.K.)

22483 (ORNL-tr-1978) ON THE EFFECT OF THE LAMINAR INCLUSION OF FOREIGN ELEMENTS IN ZONE MELTING ON THE EFFECTIVE DISTRIBUTION COEFFICIENTS. Barthel, J.; Eichler, K. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Krist. Tech., 2: 205-15(1967). 12p. Dep. CFSTI.

The influence of growth rate fluctuations due to turbulent convection in the liquid on the distribution of tungsten as a solute in molybdenum after zone melting was studied. Theoretically and experimentally, the fluctuations were found to have no effect on the macroscopic distribution function but to change the macroscopic distribution coefficient towards one. Thereby, the effectiveness in zone melting as a process of purification is lowered. Furthermore, the dependence of the macroscopic distribution coefficient on the zoning speed as given by the Burton-Prim-Slichter-theory and valid to homogeneous crystal growth, is eliminated by the fluctuations. (auth)

22484 (ORNL-tr-3009) ALLOY FORMATION BETWEEN LOW- AND HIGH-MELTING METALS BY VOLATILE METAL HALIDE REDUCTION AND ELUCIDATION OF THE STRUCTURE OF THESE ALLOYS. Heumann, Th.; Venker, H. (European Atomic Energy Community). Translated for Oak Ridge National Lab., Tenn., from report EUR-4041. 49p. Dep. CFSTI.

A process is described which permits the production of alloys between low- and high-melting metals by conducting volatile halides of the highest-melting component through the fused low-melting metal and reducing them. The metal atoms liberated in this manner can react with the melt in the nascent state without kinetic inhibitions, such as an insufficient diffusion rate, which interfere with the adjustment of the equilibrium at relatively low temperatures. In this manner, Mo-Zn and Nb-Zn alloys were produced which were subjected to examination by microscopy, thermal analysis and x rays in order to elucidate the phase diagrams. (auth)

22485 (SC-DR-68-865) DYNAMIC COMPACTION OF INITIALLY HEATED POROUS MATERIALS. Herrmann, Walter (Sandia Labs., Albuquerque, N. Mex.). Apr. 1969. 55p. Dep. CFSTI.

A previously developed theory for the dynamic compaction of ductile porous materials was modified to include an explicit dependence of compaction yielding on temperature, via the internal energy, and its limitations are discussed. While experimental verification is lacking, the theory should provide a framework for the analysis of future experimental data. (auth)

22486 MACHINING OF TUNGSTEN ALLOY FOR NUCLEONIC INSTRUMENTS. Smith, F. R.; Todd-Pokropek, A. E.; Williams, E. S. (Middlesex Hospital Medical School, London). Med. Biol. Eng., 6: 561-2(Sept. 1968).

Experience in the use of a tungsten alloy (G.E.C. Heavy Alloy: sp gr ~ 17.0; hardness 290 D.P.N.), is reported and attention is drawn to the relative ease with which it can be used in a modestly equipped workshop. A collimator was made having ~2400 holes of 2.5 cm axial length, 2.5 mm dia, and with septa 0.05 mm thick. The drills were of solid tungsten carbide and 7 were used owing to breakage occurring during drilling. A drill speed of 2300 rpm was satisfactory and no lubrication was necessary. Since the manufacture of this parallel hole collimator, it was shown to be equally feasible to make tapered holes using a block of the same tungsten alloy. It appears that with ordinary workshop facilities this alloy could be used to construct many varieties of collimator. It is desirable to use it to obtain a given radiation absorption in a minimum thickness of absorber or where the septa in a multihole collimator are too thin for lead to be a possible alternative. (BBB)

22487 NIOBIUM BASE ALLOY. Schussler, Mortimer (to Union Carbide Corp.). U. S. Patent 3,436,214. Apr. 1, 1969. Filed Mar. 22, 1967.

A niobium base alloy is described which consists of about 5 percent vanadium, 1 percent zirconium, from about .005 to about .04 percent carbon with the balance being niobium and incidental adventitious impurities. The resultant alloy is both cold rollable and ductile. (Offic. Gaz.)

22488 HIGH-TEMPERATURE INERT-GAS PURIFICATION OF REFRACTORY METALS COMPACTS. Rerat, Carlos F. (Kawecki Chemical Co., Boyertown, Pa.). Met. Soc. Conf., 34: Pt. 1, 281-90(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

The use of inert gas for high temperature sintering of Nb and Ta compacts produces purifications comparable to those obtained by sintering under vacuum if sufficiently high inert gas flow rates are employed. The inert gas used was argon. Inert gas sintering lends itself to the application of continuous process techniques in high temperature vacuum sintering normally performed in batch operations. (F.S.)

22489 HYDROGEN REDUCTION OF MOLYBDENITE USING SULFUR ACCEPTORS. PART I. CALCIUM OXIDE. Kay, Herbert (Climax Molybdenum Co., New York). Met. Soc. Conf., 34: Pt. 1, 33-44(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

Reduction of MoS_2 in hydrogen occurs at significant rates in the temperature range of 1500 to 1800°F in the presence of calcium oxide. More than 80% of sulfur in MoS_2 may be solubilized in 10% HCl after hydrogen treatment at 1800°F. Better gas-solid contacting may be expected to improve the extent of sulfur elimination. Hydrogen pressure and prolongation of treatment times do not appear to be important factors. Production of molybdenum metal from MoS_2 via the predicted reaction $MoS_2 + 2H_2 + 2CaO = Mo + 2CaS + 2H_2O$ is a distinct possibility at temperature levels considerably lower than by vacuum dissociation or by tin reduction. Reoxidation of molybdenum metal so-produced is apparently a factor, but sulfur elimination is accomplished nevertheless. Other alkaline earth oxides as sulfur acceptors may be predicted on the basis of thermodynamic affinity for sulfur. (auth)

22490 THE HYDROGEN REDUCTION OF MOLYBDIC OXIDE IN A FLUIDIZED-BED REACTOR. Michael, A. B. (Milwaukee School of Engineering); Hanway, John E. Jr. Met. Soc. Conf., 34: Pt. 1, 21-31(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

Experimental results indicate that high-quality molybdenum metal can be consistently produced by the reduction of molybdic oxide with hydrogen at 955°C in a fluidized-bed system. The weight loss of the product averaged about 0.015%. Molybdenum metal can be produced at temperatures as low as 675°C, but it is difficult to reach low oxygen levels at this temperature. Molybdenum produced at a reduction temperature of 815°C had an average oxygen content of about 0.045%; however, it was difficult to produce a product of consistent quality at this temperature. High degrees of conversion of the molybdic oxide feed can be attained in the process and no critical difficulties in supplying the thermal energy necessary for the reduction reaction were encountered. Efficient capture of the feed material can be obtained and agglomeration or growth of the bed particles can be made to occur. A granular product of essentially spherical shape can be produced. Commercial development of the fluidized-bed hydrogen reduction process for molybdenum would provide a continuous high-capacity process which is more efficient and less costly than present methods for producing metallic molybdenum. (auth)

22491 UTILIZATION OF A GAS RECYCLE SYSTEM FOR THE HYDROGEN REDUCTION OF MOLYBDIC OXIDE. Kay, Herbert (Climax Molybdenum Co., New York); Langston, B. G. Met. Soc. Conf., 34: Pt. 1, 5-20(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

Data are presented to show that by use of a gas recycle system, sufficient control can be maintained to permit the conversion of molybdic oxide to molybdenum dioxide on a continuous basis. The subsequent reduction of the molybdenum dioxide to a molybdenum metal results in the production of a product, which can be used as an alloying constituent or treated further to produce a feed for the arc-melting furnace. The work in the retort system showed that on a batch-basis, molybdic oxide could be converted directly to metal which would meet the requirements for arc melting. (auth)

22492 HIGH TEMPERATURE REFRACTORY METALS. Symposium, New York, February 1965. Krivsky, W. A. (ed.). Metallurgical Society Conference, Volume 34, Part I. New York, Gordon and Breach Science Publishers Inc., 1968. 539p. $49.00. (CONF-650227-(Pt.1).

Information in the volume is presented in 35 papers. A separate abstract was prepared for each of 24 papers. Papers for which no abstracts were prepared are concerned with Mo reserves, Be recovery and toxicity, Ti metallurgy, and production of pyrochlore concentrates. (J.R.D.)

For abstracts of individual papers see: 21628, 21669, 22452, 22453, 22472, 22488–22491, 22493–22500, 22529, 22561, 22562, 22623, 22633, 22684, and 22685.

22493 PROCESSES FOR THE EXTRACTION OF BERYLLIUM FROM FLOTATION CONCENTRATES OF BERYL. Everest, D. A.; Napier, E.; Wells, R. A. (National Chemical Lab., Teddington, Eng.). Met. Soc. Conf., 34: Pt. 1, 113-28(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

A broad outline is given on the extraction of beryllium from flotation concentrates of beryl. Two main breakdown methods were investigated. The first is the Copaux process in which beryl is roasted with sodium fluorosilicate; this method can be applied to the treatment of beryl flotation concentrates provided that loss of silicon tetrafluoride at the roasting stage is minimized, and that the feed material is low in calcium and phosphate. Methods of leaching the roasted product are discussed. The second method involves fusion of the beryl or beryl-bearing concentrate, either with or without addition of lime, and then quenching the melt to obtain a glass. Beryllium is leached from such amorphous glasses with dilute acid, or from the devitrified glasses with more concentrated acid. The quantity of alkali in the feed material, either as added lime or in the beryl feed is of crucial importance. It strongly affects the beryllium extraction from the amorphous glasses, the rate and products of devitrification, and the amount of beryllium which can be leached from the devitrified glass. The flame-fusion method provides a new approach to the treatment of beryl concentrates. This technique allows the individual particles of a mineralogical mixture to be fused without mixing taking place. Although work is incomplete the method shows some promise. Solvent extraction with di-(2-ethylhexyl) phosphoric acid is considered to provide the best method of separating beryllium from aluminum when these are present in a sulfate liquor. This is especially true for the relatively impure liquors obtained by treating beryl flotation concentrates. Solvent extraction also provides an alternative method for the purification of the crude hydroxide products of the Copaux process. (auth)

22494 PRODUCING HIGH-HAFNIUM MATERIAL FROM ZIRCON. Elger, Gerald W.; Banning, Lloyd H. (Bureau of Mines, Albany, Oreg.). Met. Soc. Conf., 34: Pt. 1, 353-73(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

A method is described for producing high-hafnium content feed material for hafnium-zirconium separation plants. Fusion-leach-fractional crystallization studies were conducted in specially built laboratory equipment. Mixtures of zircon, potassium silicofluoride and a potassium salt were electrically resistance fused to form soluble potassium zirconium hexafluoride-potassium hafnium hexafluoride salts. Over 90% of the zirconium and hafnium was extracted from the reaction product in dilute hydrofluoric acid by a simulated countercurrent operation. About half of the hafnium extracted remained in the cooled leach liquor that had hafnium-zirconium ratios (100 Hf/Hf + Zr) above 6. A multiple redissolution-recrystallization technique was used to recover the hafnium from the primary salt crystallized from cooled leach liquor and to increase the overall hafnium recovery to about 83% in the hafnium enriched mother liquor. The recrystallized salt had a hafnium-zirconium ratio of about 0.5. (auth)

22495 EXTRACTIVE METALLURGY OF ZIRCONIUM AND HAFNIUM. Schlechten, A. W. (Colorado School of Mines, Golden). Met. Soc. Conf., 34: Pt. 1, 347-52(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

A resume of the development of zirconium and hafnium production in the U. S. and a description of present production facilities are given. Different approaches to reduction and refining are listed and some speculations are made as to future changes in the industry. (auth)

22496 HAFNIUM ELECTROREFINING. Goodrich, A. C.; Spink, D. R. (Carborundum Metals Co., Akron, N. Y.). Met. Soc. Conf., 34: Pt. 1, 385-96(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

Molten-salt electrorefining of hafnium was shown to be technically feasible. The product was amenable to standard fabrication techniques. Semi-works scale operation was designed to determine whether this process will be economically justifiable. The refining process may be conducted in a mild steel or stainless steel cell using a fused mixture of 95 molecular % NaCl–5% KCl containing soluble Hf. (J.R.D.)

22497 METALLURGICAL PROCESSING OF SILVER INFILTRATED TUNGSTEN. Matt, R. E. (Aerojet General Corp., Sacramento, Calif.); Warga, J. J. Met. Soc. Conf., 34: Pt. 1, 421-40(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

The production of silver infiltrated tungsten matrices suitable for use in solid rocket nozzle inserts has been described, and it has been shown that the control of the individual phases of processing contribute equally to the resultant quality of the composite material. The successful development of the processing techniques that are involved has led to the exploitation in uncooled rocket nozzles of a material of high room and elevated temperature strength, possessing unique thermal properties. (auth)

22498 THE RAPID REDUCTION OF TUNGSTEN COMPOUNDS WITH A SOLID ORGANIC REDUCING AGENT. Supiro, Lester D.; Davidson, Bernard H. (M and R Refractory Metals, Inc., Springfield, N. J.). Met. Soc. Conf., 34: Pt. 1, 409-19(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

Organic reducing agents used with tungsten compounds for the production of tungsten metal powders are described and evaluated. Main advantages found for the use of the Hexamine Process employing hexamethylenetetramine are smaller and more easily operated facilities producing savings in equipment, labor, and power. (F.S.)

22499 RHENIUM SOURCES AND METHODS AND EXTRACTION AND REFINING. Davenport, W. H. (Chase Brass and Copper Co., Inc., Cleveland). Met. Soc. Conf., 34: Pt. 1, 465-89(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

Rhenium has unique properties which recommend its use for many electronic and high temperature applications. Despite its relative scarcity, methods of extraction have been developed and rhenium is now available in significant quantities. The history of this development is traced briefly. The geological occurrence and economic sources and reserves are examined in the light of current and future production capacity. Practically the sole present commercial sources of rhenium are flue gases and dusts resulting from the roasting of molybdenite concentrates produced from porphyry copper deposits. Descriptions are given of the principal industrial processes now being used to recover rhenium from these sources and factors influencing the efficiency of recovery are discussed. (auth)

22500 VAPOR-PHASE DEPOSITION OF TUNGSTEN FROM TUNGSTEN HEXAFLUORIDE AND HYDROGEN. Hoertel, F. W. (Bureau of Mines, Rolla, Mo.). Met. Soc. Conf., 34: Pt. 1, 519-27(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

High-purity tungsten with a columnar grain structure, with Knoop microhardness values with a 100 gram load ranging from 240 to 714, and with an average density of 19.249 was vapor-deposited on various substrates by reducing commercial WF_6 with hydrogen. Deposition temperatures ranged from 300 to 750°C. Bonding of the tungsten to the various substrates was mechanical. Exceptionally adherent bonding to copper was achieved. A table of average values of detectable impurities, a schematic diagram of the apparatus used, two photomicrographs of grain structure, and three photographs and one x-ray photograph of deposits are included. (auth)

22501 IMPROVEMENTS IN OR RELATING TO URANIUM FUEL ELEMENTS. (to Compagnie pour l'Etude et la Realisation de Combustibles Atomiques). British Patent 1,146,704. Mar. 26, 1969. Priority date Apr. 3, 1965, France.

A process for production of U fuel elements having improved grain fineness and stability after direct casting and cooling within a wide range of cooling rates comprises adding to the U containing one or more of the grain fineness elements, Mo, Cr, Fe, Si, or Ge, either B or Be in a total quantity of from 5 to 2000 ppM and then casting the element. (B.L.M.)

22502 ZIRCONIUM-BASE ALLOYS. (to Atomic Energy of Canada Ltd.). British Patent 1,145,931. Mar. 19, 1969. Priority date May 20, 1966, Canada.

A method of treating a Zr alloy containing 0.5 to 5 wt % Nb, 0.005 to 1 wt % Be, and optionally one or more of the following elements, Sn, Cu, Fe, Cr, Mo, V, W, Ta, Ni, Y, Sb, and Te, with a total alloying addition of no more than 10 wt % is described. The alloy is suitable for use in reactor structural materials, which are exposed to pressurized water, boiling water, or CO_2. The alloy is heat treated at ~50°C below the upper critical temperature for 15 min to 2 hr, quenched to produce a fine grained martensitic structure, cold worked for 15 to 30%, aged at 500 to 600°C for 10 to 30 hr, and subjected to further cold working. (B.L.M.)

22503 FEASIBILITY OF RESISTANCE WELDING IN HARD VACUUM. Cheever, D. L.; Howden, D. G.; Monroe, R. E. (Battelle Memorial Inst., Columbus, Ohio). Weld. J. (N.Y), 48: 133s-40s(Apr. 1969).

Resistance spot welds were made in 2014 aluminum alloy, Type 304 stainless steel, and Ti-6Al-4V in air and in vacuum. The resulting welds were x-rayed and tested in tensile shear to determine the maximum load at failure. The 2014 aluminum alloy welds and stainless steel welds showed no significant difference in load at failure between those made at the same welding machine settings in air and in vacuum. The titanium alloy welds made in a vacuum showed a definite decrease in load at failure. It was found that welds made at low electrode forces (about 300 lb) could support loads equal to or greater than welds made at the higher electrode forces normally recommended for those alloys. Welds in titanium and, to a lesser extent, aluminum showed a decreasing load at failure when exposed to vacuum for increased time periods prior to welding. From this research, it was concluded that resistance spot welding is an excellent candidate process for joining all three materials in space. (auth)

22504 NATURE OF WELD SURFACE RIPPLES. Cheever, D. L.; Howden, D. G. (Battelle Memorial Inst., Columbus, Ohio). Weld. J. (N.Y.), 48: 179s-80s(Apr. 1969).

Weld surface ripples are the result of incremental solidification. The ripples delineate solute, gas porosity, and dislocation concentrations. Ripples appear to be inherent to rapid solidification processes. (auth)

22505 PRODUCTION AND UTILISATION OF URANIUM IN NUCLEAR REACTORS. May, J. R. At. Energy Aust., 12: 8-17(Jan. 1969).

Some of the types of fuels for use in power reactors and their method of production are described. The UO_2 fuel for a natural uranium, heavy-water moderated reactor, which has possible application in Australia, is considered. The program to demonstrate the production of nuclear grade UO_2 and to improve technology and develop new processes is outlined. (J.C.W.)

22506 MECHANICAL PROPERTIES OF DISPERSION-STRENGTHENED SPRAY-QUENCHED Al-V ALLOYS. Moss, Marvin; Schuster, D. M. (Sandia Lab., Albuquerque, N. Mex.). ASM (Amer. Soc. Metals), Trans. Quart., 62: 201-5(Mar. 1969).

It has been demonstrated that metals may be dispersion strengthened by plasma spray-quenching. Two aluminum-vanadium alloys (2.6 and 4.9 wt % V) were prepared in powder form and plasma sprayed to produce extremely rapidly quenched material. This resulted in a metastable solid solution which was decomposed into a fine dispersion of Al-V intermetallic particles. Specimens up to 0.15 in. thick were deposited with densities exceeding 85% of theoretical, and hot pressed (70% reduction in thickness) at 300°C to densify and work the material. The 4.9 wt % V alloy possessed an ultimate tensile strength of 50,300 psi with an 0.2% offset yield strength of 43,800 psi. Hardness measurements indicated an improved resistance to recrystallization at elevated temperatures. (auth)

22507 WEAR- AND ACID-RESISTANT SINTERED WELDING MATERIALS FOR THE CHEMICAL INDUSTRY. Baeumel, A.; Adamitsch, W. (Boehler and Co. AG, Duesseldorf, Ger.). Chem.-Ing.-Tech., 41: 22-6(Jan. 1969). (In German).

New sintered welding materials based on tungsten carbide in cobalt/chromium/tungsten matrix alloys containing additional nickel, molybdenum, and copper showed high corrosion resistance and wear resistance. The welding rods were manufactured by an extrusion process and were sintered at 1150°C. The resistance of the materials to sulfuric acid and their particularly high hot strength warranted special mention. Their applications in chemical-plant construction are considered. (auth)

22508 PROCESS FOR THE PREPARATION OF BERYLLIUM PRODUCTS. Logerot, Jean-Marie (to Commissariat a l'Energie Atomique). British Patent 1,148,766. Apr. 16, 1969. Priority date Oct. 14, 1965, France.

A process for preparing clad beryllium products is described. A cast beryllium blank is mechanically clad one layer of at least one metal or metal alloy such as aluminum, antimony, magnesium, or zinc. Drawing, extrusion, hammering, or rolling below 620°F is employed in mechanical cladding. (F.S.)

22509 METHOD FOR ROLLING OF TUBES OF ZIRCONIUM OR ZIRCONIUM ALLOYS. Edstroem, J. O.; Innerman, S. E.; Mills, B. E. (to Sandvikens Jernverks AB). Swedish Patent 219,456. Mar. 12, 1968. Filed Feb. 1, 1966. (In Swedish).

A method is described for rolling of tubes of zirconium or zirconium alloys. The tubes are rolled step-by-step on a cylindrical mandrel. The reduction of cross section in every rolling step is 50 to 80% and the reduction of inner diameter is insignificant. A peripheral direction of precipitated hydrides is obtained by autoclave treatment or by another way of heat treatment. (Sweden)

22510 METAL FABRICATING USING HIGH EXPLOSIVES. Agricola, K. R. West. Mach. Steel World, 59: No. 10, 20-4 (Oct. 1968).

The advantages of explosive forming of high-strength alloys, including Ti, in aerospace and commercial applications are discussed. Several explosive formed parts are illustrated. Explosives used are dynamites, TNT, and Pentotites. Stringent requirements on contour, diameter, and skin smoothness are met and, because of close tolerances, improved properties and reduced machining costs, explosive forming is economically competitive. Explosive bonding of metals eliminates the need for elevated temperature treatment, elaborate fixturing and time-diffusion of atoms; only chemical cleaning and degreasing is needed before bonding. Tubes and pipes have been clad with Al, Cu, Ta, Ti and stainless steel by explosive bonding and a Hastelloy X ring has been bonded to an Inconel cast rotor wheel. (Metals Abstr.)

22511 BERYLLIUM FOR FUTURE TECHNOLOGY. Hardy, Norman E. Engineering, 207: 576-9(Apr. 11, 1969).

The Be fabrication methods and equipment at the Royal Ordnance Factory, Cardiff, are described. Safety measures are outlined. (UK)

Properties Evaluations

Refer also to abstracts 21886, 22458, 22506, 22568, 22575, 22576, 22582, 22608, 22613, 22616, 22618, 23946, and 23984.

22512 (AGN-8289(Vol.2)) EVALUATION STUDY OF HASTELLOY X AS A NUCLEAR CLADDING. VOLUME II. MECHANICAL PROPERTIES INVESTIGATIONS. Final Technical Report. Baciarelli, R. M.; Titus, G. W. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). Aug. 1968. Contract AT(04-3)-368. 166p. Dep. CFSTI.

The data and results obtained in a program devoted to studies of creep properties of Hastelloy Alloy X tested by a multiple-specimen centrifugal creep technique are presented. The centrifugal creep tests were performed at 1300 and 1400°F in argon and at 1800°F in air, and the results were compared with data developed in single-specimen tensile creep tests performed at the same conditions. The theory of centrifugal creep testing is presented together with a computer method and for data reduction which converts specimen deflection data, obtained in centrifugal testing, to uniaxial creep data. The investigation revealed that the differences between tensile and centrifugal creep data are not as significant as the variations in tensile creep data from different sources reported in the literature. Where there are differences between tensile and centrifugal creep, data resulting from centrifugal creep tests are consistently more conservative than data from tensile creep tests. It was also observed that the differences between centrifugal and tensile data are minimal when the tests are performed at lower temperatures in inert atmosphere. Surface conditions and thermal history have a significant influence on both the initial and final creep rates determined by both testing methods. A low-cobalt content heat of Hastelloy X was found to be most creep resistant when tested at 1300°F but least creep resistant when tested at 1400 and 1800°F. This behavior was attributed to the aging characteristics of the alloy at the different temperatures. Specimens of two heats tested had different tensile creep curves when tested at 1800°F; these were attributed to differences in the work hardening and stress recovery mechanisms. The creep rates of specimens of all the heats tested became essentially the same after long exposure at 1300 and 1400°F. However, this situation did not occur in specimens tested at 1800°F in air; the differing creep rates in this case are attributed to differences in the precipitation mechanism which occur at 1800°F in air. As-received and exposed specimens were examined metallographically and particles were extracted for x-ray diffraction analyses. Sigma phase and M_6C and $M_{23}C_6$ carbides were identified in the aged specimens, and results of the analyses indicated that the amount of sigma phase precipitation in the specimens was, primarily, a function of the applied stress. Microhardness measurements were made on as-received and exposed specimens. Significant increases in hardness were observed after testing and, in general, the hardness seemed to increase slightly with the test temperature and stress. Important design implications are associated with these experimental observations. In design situations where other than pure uniaxial stress will occur, conventional uniaxial creep data will be less conservative than that generated by centrifugal creep testing. Therefore, creep measurements developed by combined bending-tension or pure bending tests will be necessary to develop precise design data. (auth)

22513 (BNWL-790, pp 4.11-12) RADIATION EFFECTS ON THE MECHANICAL PROPERTIES OF TYPE 347 SS FERMI WRAPPER TUBE. DeMastry, J. A.; Sheckherd, J. W.; Wullaert, R. A. (Battelle Memorial Inst., Columbus, Ohio).

A program was undertaken to determine the radioinduced changes in the mechanical properties of Type 347 SS irradiated as a wrapper tube in the fast flux of the Fermi Reactor, and to compare these changes with stainless steel irradiated in mixed fast and thermal flux. Tensile specimens have been prepared from blanks cut from an irradiated tube. Testing of tensile specimens from an unirradiated tube was initiated, and the preliminary room temperature results are given. (L.C.L.)

22514 (BNWL-790, pp 8.1-10) DEVELOPMENT OF TEST PROCEDURES, FRACTURE TOUGHNESS OF REACTOR VESSEL STEELS. Ripling, E. J.; Crosley, R. B. (Materials Research Lab., Inc., Glenwood, Ill.).

The fracture behavior of Type A302B steel for reactor pressure vessels was investigated. Attention was focused on the specimen thickness required to establish reliable plane strain toughness values, and in particular, on the effect of loading rate on the required thickness. The rate sensitivity of the crack toughness was also evaluated. Details are given on specimen selection and the materials testing procedures used to determine yield stress crack toughness. Crack toughness measurements were made at −70, 0, and 70°F on specimens which had been fatigue cracked at −40°F. The results on the correlation of thickness correction with initiation and arrest toughness are plotted. The data indicated little strain rate sensitivity of crack toughness. (L.C.L.)

22515 (COO-1198-620) MAGNETIC RESONANCE STUDY OF AGE HARDENING IN Cu-Be ALLOYS. Danesh, Kamalodin Benadki (Illinois Univ., Urbana). Feb. 1969. Contract AT-(11-1)-1198. 37p. Dep. CFSTI.

The resonance absorption intensity of copper-beryllium alloys was measured for alloys in the solution treated condition, and it was found that the intensity is proportional to $(1-c)^{20}$ where c is the atomic percent of Be. The aging behavior of the copper-beryllium alloys was studied. Alloys containing less than 1.5 wt % beryllium were not suitable for age-hardening. The addition of Co to the age-hardenable binaries of copper and beryllium hastened the aging process. The nuclear magnetic resonance intensity measurements of the aged alloys indicated that possibly lattice strains produced by the coherent β' particles are responsible for the intensity attaining only part of its theoretical value. The absorption intensity of the 2 wt % Be alloy reached its peak after one hour of aging at 450°C, and then it remained essentially unchanged. Thus, to follow the aging process in the high Be alloys, it is more convenient to use lower aging temperatures. (auth)

22516 (GEMP-669) THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF ZIRCALOY-4. Feith, Allen D. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Oct. 1966. Contract AT(40-1)-2847. 19p. Dep. CFSTI.

The thermal conductivity of Zircaloy-4 was measured in a radial heat flow device. Results of these measurements indicate that the conductivity of this material increases with temperature from 0.16 W/cm°C at 400°C to 0.425 W/cm°C at 1500°C. A platinum–platinum +10% rhodium thermocouple was used as a probe for temperature measurements up to about 1150°C whereas an optical pyrometer was used above this temperature. Electrical resistivity measurements were made from room temperature to 920°C using a rod specimen which was fabricated from the same raw material as the thermal conductivity specimens. Results of this study show that the electrical resistivity of Zircaloy-4 is considerably higher than essentially pure zirconium. The data indicate a maximum in resistivity of 140.0×10^{-6} ohm-cm at 810°C with a sharp decrease in resistivity as the material undergoes a phase change from hexagonal close packed (α) to the body centered cubic (β) phase at ~860°C. (auth)

22517 (N-68-37053) MECHANICAL PROPERTIES AND COLUMN BEHAVIOR OF THIN WALL BERYLLIUM TUBING. Rummler, Donald R.; Dexter, H. Benson H.; Harth III, George H. Buchanan, Raymond A. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Oct. 1968. 77p. (NASA-TN-D-4833). CFSTI.

The results of an experimental investigation to determine the mechanical properties and column behavior of commercially produced beryllium tubing at room temperature are presented. The investigation included three types of extruded tubing and one type of plasma-sprayed and sintered tubing. The diameters of the tubes ranged from 0.25 to 0.75 in. (6.35 to 19.05 mm). Wall thickness was either 0.020 or 0.040 in. (0.508 or 1.016 mm). Microhardness measurements and metallurgical studies were performed to characterize the tubing microstructure. On the basis of the results of mechanical-property determinations and column tests, the extruded tubing appeared to be suitable for use in truss-type structures. Column buckling loads could be predicted satisfactorily by using the tangent modulus, derived from compressive stress–strain curves, in the inelastic column-buckling equation. The results also indicated that the reproducibility of the dimensions and the mechanical properties of the extruded beryllium tubing were comparable to that of other aircraft structural materials. (auth) (STAR)

22518 (RD/B/N-1295) ASPECTS OF THE FAILURE OF LARGE STEEL PRESSURE VESSELS. Edmondson, B.; Formby, C. L.; Jurevics, R.; Stagg, M. S. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb. 1969. 18p. (JNPC-SSG/P-(69)15). Dep.

Studies are described on the processes leading up to catastrophic failure of a pressurized structure. Measurements are given of crack opening displacements relevant to failures initiating from pre-existing defects, with particular attention to the case of structures which have been loaded on previous occasions. This information is then related to data on strain aging of cracked bars subjected to simulated operational cycles. The material properties important in high strain fatigue crack propagation were examined experimentally, and a correlation between propagation rates and measured crack tip strains is discussed. The final stage of failure of a structure, extension of a fast running crack beyond the immediate region where it initiates, is considered in terms of the fracture toughness at appropriate crack velocities. Measurements of this parameter involving destruction of large pressurized vessels are described. (auth)

22519 (RP-SR-2) PHOEBUS-2 MATERIALS. Final Report. (Aerojet-General Corp., Sacramento, Calif.). Sept. 1967. Contract SNPC-35. 331p. Dep. CFSTI.

The report documents, in abbreviated form, all metallurgical testing conducted in support of the Phoebus 2 Nozzle Program. The tensile properties of forgings, strip, weldments, and brazements are presented as individual test data and as statistical means with sigma limits through the temperature range of –423 to 1800°F. The mechanical properties of shear strength, bearing strength, low-cycle fatigue, and thermal cycling are also presented. In addition, the manufacturing and fabrication processes are presented from raw material melting through fabrication of individual hardware components. Metallurgical analysis of thermal treatments and processing is also provided. (auth)

22520 (SC-RR-68-784) EFFECT OF HOLES ON THE DYNAMIC BREAKING STRENGTH OF RINGS. May, Gerald W. (New Mexico Univ., Albuquerque); Ellett, D. Maxwell (Sandia Labs., Albuquerque, N. Mex.). Apr. 1969. 33p. Dep. CFSTI.

The problem of dynamic stresses in rings with cutouts was investigated. Applicable literature was studied with the view toward analytical prediction of the dynamic stress concentration factors. An experimental program was performed in which rings of brittle material were subjected to impulsive loading by means of flyer plates, and the effect of various shapes of cutouts on the breaking strength was found. These results are discussed and compared to the predicted stress concentration factors. (auth)

22521 (SCL-RR-68-96) GENERAL LIQUID-VAPOR EQUATION-OF-STATE AND APPLICATION TO ALUMINUM. Anderson, P. D. (Sandia Labs., Livermore, Calif.). Apr. 1969. Contract AT(29-1)-789. 36p. Dep. CFSTI.

All thermodynamic functions can be obtained for a gaseous or liquid metal from a representation of an energy–entropy–volume surface. It is shown that this is equivalent to the representation of three curves (all functions of volume) if the simplifying assumption is made that the heat capacity is a function only of volume. This analysis is then applied to aluminum, using all known experimental information to pin down the curves as much as possible. The requirement that reasonable thermodynamic behavior prevail results in further definition of the curves. The results can be used to obtain numerical values of pressure, volume, and energy (as well as other thermodynamic functions) which can then be used in hydrodynamic calculations. (auth)

22522 (UCRL-18676) SOME ANTICIPATED DEVELOPMENTS IN PHYSICAL METALLURGICAL RESEARCH. Zackay, Victor F. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1969. Contract W-7405-eng-48. 40p. (CONF-690403-1). Dep. CFSTI.

From Centenary Celebration of the Iron and Steel Institute Conference, London, England.

Changes taking place in the conduct of physical metallurgical research in the United States are brought about by complex economic, managerial, and technical forces. An analysis of statistics suggests that a greater emphasis will be placed on applied rather than on fundamental research in the ensuing decade. The forces active in producing this change in emphasis are discussed. Continuing heavy demands by industry for improved materials are affecting changes in both the objectives and the methods of physical metallurgical research. An example is taken from the nuclear power industry to illustrate some of these changes. The specific metallurgical problem of the limited strength, ductility, and toughness of high strength steels is examined. Processes are suggested whereby high strength steels of greater toughness can be made. A newly developed class of steels is described having both high strength and high ductility. Lastly, the present upper limits of the strength and ductility of steel are defined. (auth)

22523 (UCRL-50581) SHOCK-INDUCED PHASE TRANSITION PRESSURES IN Fe–Cr AND Fe–Cr–Ni ALLOYS. Gust, W. H.; Royce, E. B. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 1, 1969. 8p. (CONF-681202-2). Dep. CFSTI.

From Meeting of the American Physical Society, San Diego, Calif.

The variation of shock-induced phase-transition pressure with alloy composition was observed for several Fe–Cr and Fe–Cr–Ni alloys by use of the inclined mirror technique. It was found that transition pressures for Fe–Cr alloys varied continuously from the known 130-kbar value for pure iron to 230 kbar for 30 percent Cr content. Alloys of the Fe–Cr–8 percent Ni series exhibited an almost linear decrease in transition pressure from 120 to 80 kbar as Cr was increased from zero to 18 percent; no transition was observed for an 8 percent Ni-22 percent Cr alloy up to 124 kbar. Further systematic decrease in phase transition pressures was observed for Fe–Cr–12 percent Ni and Fe–Cr–16 percent Ni alloys. The results for the 18 percent Cr-8 percent Ni alloy indicated an elastic precursor of 23 kbar and a phase-transition pressure of 80 kbar. (auth)

22524 (WAPD-TM-818) EFFECT OF THERMAL TREATMENT ON THE ALLOY DISTRIBUTION OF ZIRCALOY-2. Gessner, R. F. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar. 1969. Contract AT(11-1)-Gen-14. 21p. Dep. CFSTI.

Electron microprobe analyses were performed on specimens of Zircaloy-2 which were slowly cooled from the alpha plus beta and beta regions as well as on as-rolled specimens. Tin was found to concentrate in alpha grains formed during the cooling with concomitant tin depletion in the grain boundaries. Grain boundaries were enriched in iron, chromium, and nickel, but the grains themselves showed no evidence of depletion of these constituents. This anomaly was attributed to the analytical method utilized where a very fine electron beam was focused on the specimen. (auth)

22525 ISOTOPE EFFECT IN SELF-DIFFUSION IN IRON. Walter, C. M.; Peterson, N. L. (Argonne National Lab., Ill.). Phys. Rev., 178: 922-9(Feb. 15, 1969).

The isotope effect in self-diffusion was measured in the δ, γ, and α phases of Fe using ^{52}Fe–^{59}Fe. The isotope-effect data, together with measurements taken on the effect of Co solute additions on Fe self-diffusion, were used to deduce the most likely mechanisms for self-diffusion in all three phases. The data are consistent with a vacancy mechanism in fcc γ-Fe. In bcc α- and δ-Fe, the data are consistent with a vacancy or interstitialcy mechanism. The mechanism seems to be the same in δ- and in α-Fe. (auth)

22526 MECHANISM RESPONSIBLE FOR THE EFFECT OF RHENIUM ON THE BRITTLE FAILURE OF REFRACTORY METALS. Saakyan, I. M.; Sarrak, V. I.; Fonshtein, N. M.; Entin, R. I. Fiz.-Khim. Obrab. Mater., No. 2, 79-86(Mar.-Apr. 1968). (In Russian).

The effect of Re on the motion of dislocations in the crystal lattices of Mo and W (and hence on the critical temperature at which these metals pass into the brittle state) was studied by determining the amplitude dependence of the internal friction of Mo–Re and W–Re alloys as a function of composition. Rhenium lowered the interaction energy between dislocations and impurity atoms of the interstitial type, i.e., increased the mobility of the dislocations, weakening their blocking effect. (Metal Abstr.)

22527 HYDROGEN EMBRITTLEMENT IN AUSTENITIC STEELS AND NICKEL-BASE ALLOYS. Lagneborg, R. (Aktiebolaget Atomenergie, Stockholm). J. Iron Steel Inst. (London), 207: 363-6(Mar. 1969).

The susceptibility of different austenitic stainless steels and nickel-base alloys to hydrogen embrittlement was examined by tensile testing of hydrogen-charged unnotched specimens at temperatures between –100° and +200°C. The investigation included materials of the following types: 18Cr–11Ni, 18Cr–14Ni, 20Cr–25Ni, 20Cr–35Ni, and 16Cr–75Ni. Only 18Cr–11Ni and 16Cr–75Ni were embrittled. Between about 15 and 35% Ni these types of alloys displayed no tendency to embrittlement. The embrittlement was maximum at –50°C. For the 16Cr–75Ni material the ductility of the hydrogen-free material was restored at about +200°C; in the 18Cr–11Ni steel this occurred at a somewhat lower temperature. Sharp microcracks were found in the embrittled alloys after fracture. These cracks were preferentially formed in the twin boundaries of the austenite. (auth) (UK)

22528 LATTICE THERMAL CONDUCTIVITY OF IMPURE TIN. Gueths, J. E.; Garbarino, P. L.; Mitchell, M. A.; Klemens, P. G.; Reynolds, C. A. (Univ. of Connecticut, Storrs). Contract NONR 2967(00). Phys. Rev., 178: 1009-16(Feb. 15, 1969).

Measurements of the normal- and superconducting-state thermal conductivities (K^n and K^s) were made on seven cadmium-doped tin single crystals in the temperature range 1°K < T < 4°K. Data from six specimens measured previously are also included in the analysis. Cadmium concentrations range from 0.04 to 0.97 at. %. The crystal orientations are grouped in the near perpendicular direction (direction of heat flow approximately perpendicular to the tin tetrad axis). The small fractional size of the normal-state lattice conductivity, K_g^n, precludes its direct determination from the normal-state data alone. However, the superconducting-state thermal conductivity is employed in a "universal curve" type of analysis, from which we deduce for K_g^n a $T^{2.21\pm0.04}$ dependence upon temperature and a $\rho_0^{-(0.21\pm0.04)}$ dependence upon residual resistivity. As the solid solubility limit is approached we find an additional lattice resistivity varying as $T^{-1.4}$ and increasing in magnitude with increasing impurity concentration. This is ascribed to phonon scattering by point defects and boundaries, using adjustable parameters describing the distortion about the impurity and the mean free path for boundary scattering. The best fit to the data yields values for the strain field size that are in good agreement with the x-ray data of Lee and Raynor. The apparent boundary scattering mean free path is much less than the sample diameter; this indicates large clusters of impurities in the alloy. (auth)

22529 AN INVESTIGATION OF THE TERNARY SYSTEMS MOLYBDENUM–RHENIUM–NIOBIUM AND MOLYBDENUM–RHENIUM–RUTHENIUM. Kieffer, Bernhard F.; Sedlatschek, Karl (Wah Chang Corp., Albany, Oreg.). Met. Soc. Conf., 34: Pt. 1, 441-64(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

The effects of a third alloying element on the properties of Mo–Re alloy were investigated in the ternary alloy systems Mo–Nb–Re and Mo–Re–Ru. Corrosion behavior in hydrochloric, nitric, and sulfuric acids was determined along with electric resistivity, hardness, lattice parameters, melting points, and sintering behavior. Workability of ambient and elevated temperatures was investigated. (F.S.)

22530 CREEP DEFORMATION OF Cd AND Hg AT LIQUID HELIUM TEMPERATURES. Arko, A. C.; Weertman, J. (Northwestern Univ., Evanston, Ill.). Acta Met., 17: 687-99(May 1969).

The creep behavior of mercury and cadmium single crystals was studied at temperatures of liquid helium and above. Creep was found to be temperature dependent at all temperatures down to 1.75°K. The observed creep strain generally obeyed a logarithmic time law, characteristic of the usual low temperature creep. Activation energies were calculated from the observed creep rates and temperatures. It was found that the activation energy decreases approximately linearly with decreasing temperatures and has a magnitude of about 100 cal/mole at the lowest temperatures at which experiments were carried out. The activation volume was determined from creep tests at 4.2°K and was found to be about 100 at. vol. Change in strain rate tests, performed to verify creep determinations of the activation volume, yielded slightly higher values for both mercury and cadmium. (auth)

22531 STRUCTURE AND PROPERTIES OF POROUS IONIZER MATERIALS. Kirkpatrick, M. E.; Mendelson, R. A. (TRW Systems, Redondo Beach, Calif.). Int. J. Powder Met., 5: 57-67 (Jan. 1969).

Porous structures prepared from closely classified spherical tungsten powders have been investigated to develop an understanding of the interrelations between powder size, compaction technique, compaction pressure, sintering route, and the several porosity and permeability parameters. Pore diameter, surface pore density, interpore spacing, and specific permeability data are presented in relation to processing techniques and powder size. Sintering mechanisms and the elevated temperature stability of porous structures are discussed and projected ionizer lifetimes are shown to be of the order of several thousand hours. The performance characteristics of these porous structures in an ion engine configuration are discussed at ion current densities to 50 mA/cm^2. (auth)

22532 SUPERCONDUCTIVITY AND THE METALLURGIST. Broom, T. (Central Electricity Research Labs., Leatherhead, Eng.). J. Sheffield Univ. Met. Soc., 7: 30-5(1968).

A brief review is given of the science and technology of superconductivity and its actual and potential applications, emphasizing the practical metallurgical aspects. The need for research on the pinning of vortex lines is mentioned. (UK)

22533 EFFECT OF NONMETALLIC DISPERSIONS OF THE MECHANICAL BEHAVIOR OF BERYLLIUM. Moberly, John William. Stanford, Calif., Stanford Univ., 1968. 108p. Thesis.

The effect of various nonmetallic dispersions on the mechanical behavior of beryllium-base composites was determined. The composite systems chosen for study were: beryllium-beryllium oxide, beryllium-beryllium carbide, beryllium-silicon, and beryllium-tungsten beryllide. These two-phase composites were prepared by powder metallurgical techniques chosen so as to achieve uniform dispersions of the second phase within the beryllium matrix. To determine the effect of amount of dispersoid, the beryllium oxide second phase was varied from 0.5 to 20 vol %. The silicon, beryllium carbide, and tungsten beryllide second phases were used in concentrations of 15 vol %. Mechanical tests showed that strengthening was always obtained with the addition of the second phase dispersoid. Increasing the fraction of dispersoid increased the strength, but also decreased ductility at temperatures studied (25 to 600°C). The highest strength was obtained in beryllium plus a homogeneous dispersion of 20 vol % beryllium oxide. These dispersions raised the compressive yield stress of pure beryllium from 40,000 psi to 150,000 psi but lowered the percent strain at fracture from 40 to 4% at 25°C. At 400 and 600°C, a work-softening behavior was found for the high volume fraction dispersed composites, but not for the pure beryllium samples. Microstructural analysis showed that the dispersed particles limit the beryllium grain size. Beryllium oxide is the most effective. However, in all composites the second phase particles were always present in the beryllium grain boundaries. This contributes to the strengthening but also leads to very low ductility prior to fracture. There was no indication that beryllium composites with this microstructure would lead to increased low temperature ductility in polycrystalline beryllium. (Diss. Abstr.)

22534 SIMULTANEOUS PYROLYTIC DEPOSITION OF CARBON AND BORON. Marinkovic, S.; Suznjevic, C.; Dezarov, I. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Carbon, 7: 185-93(Feb. 1969)

Boron-containing pyrocarbons were prepared at temperatures of 1400–1650°C by simultaneous pyrolytic deposition from gas mixtures containing CH_4 and BCl_3 on an induction heated graphite substrate. The deposits thus prepared, with boron content in the range 0–3 wt %, were investigated using x-ray diffraction, optical microscopy, oxidation, and apparent density determination (flotation method). The results show that B enters into both substitutional and interstitial positions in the lattice. The degree of graphitization increases considerably with increasing B content up to about 1% and then decreases. This is interpreted by assuming that up to this concentration B forms preferentially substitutional solid solution, and that in excess of this concentration it is introduced interstitially. Other properties studied, apparent density, preferred orientation, and apparent crystallite thickness, showed similar dependence on B content. Oxidation in a saturated solution of $Ag_2Cr_2O_7$ in H_2SO_4 revealed the presence of two structural components (F_1 and F_2) with oxidation rates differing by a factor of about 10^3. It was found that B causes an increase in both rate constants, and a relative decrease in the component with high oxidation rate. (auth)(UK)

22535 SULFUR DIFFUSION IN VANADIUM AND TANTALUM. Vandyshev, B. A.; Panov, A. S. Izv. Akad. Nauk SSSR, Metal., No. 1, 244-6(Jan.-Feb. 1969). (In Russian).

Equations for the relation of temperature to the coefficients for diffusion of sulfur in Ta and V are given. Autoradiography after annealing revealed a prevailing distribution of S along the grain boundaries of Ta and uniform distribution in V specimens. The theoretical appraisal of the parameters of S diffusion in V was accomplished. Suggestions are given concerning the intergranular mechanism for S diffusion in V as a result of the comparison of calculated and experimental results of the diffusion parameters. (tr-auth)

22536 DIFFUSION OF CARBON IN TANTALUM, NIOBIUM, AND VANADIUM. Son, Pongun; Miyake, Masanobu; Sano, Tadao. Technol. Rep. Osaka Univ., 18: 317-24(Oct. 1968).

The diffusion coefficients of carbon in tantalum, niobium, and vanadium were studied by sectioning method using ^{14}C as a tracer. The diffusion coefficients are described by the equations, $D = D_0 \exp(-E/RT)$ where D_0 and E are as follows: for tantalum, $D_0 = 0.012$ cm^2/sec and E = 40.3 kcal/mol; for niobium, $D_0 = 0.033$ cm^2/sec and E = 37.9 kcal/mol; for vanadium, $D_0 = 0.0049$ cm^2/sec and E = 27.3 kcal/mol. These values are compared with those obtained by mechanical relaxation method, and the results discussed. (auth)

22537 SOLUBILITY OF RARE EARTH METALS IN SOLID STATE ALUMINUM. Drits, M. E.; Kadaner, Z. S.; Nguyen Ting Shoa. Izv. Akad. Nauk SSSR, Metal., No. 1, 219-23(Jan.-Feb. 1969). (In Russian).

Electric conductivity and microsolidity measurements and microstructural analysis were used to determine the solubility of Yt, La, Ce, Pr, and Nd in solid state Al. The solubility of Yt, La, Ce, and Pr, and Nd at 620, 600, and 500°C were equal to: 0.15, 0.13, and 0.08; 0.03, 0.01, and 0.01; 0.04, 0.02, and 0.01; and 0.03, 0.02, and 0.005 wt %, respectively. The method of extrapolation was used to determine the maximum solubility of Yt, La, Ce, Pr, and Nd in solid state Al, which was equal to 0.17, 0.05, 0.05, 0.05, and 0.04 wt % (0.051, 0.01, 0.01, 0.01, and 0.008 at. %), respectively. (tr-auth)

22538 THE ACTIVATION ENERGY FOR K-STATE FORMATION IN A QUENCHED Ni PLUS 10 AT. PERCENT Mo ALLOY. Sukhovarov, V. F.; Karabaeva, V. V. (Siberian Physical-Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 9, 132-3(1968). (In Russian).

The activation energy (U) was determined by a method of combined isochronous and isothermal annealing at the initial stages of formation of the K-state on the assumption that K-state formation is controlled only by migration of single vacancies due to the high annealing temperature. Samples soaked for 3 hours at 950°C were quenched in water. Measurements of the electrical resistance were carried out at room temperature. Isothermal annealing was carried out at 300°C. The activation energy (U) was estimated graphically by plotting the time interval in the course of which during isothermal soaking the electrical resistance increases to the value at a temperature T in the case of isochronous annealing as an inverse function of the temperature T. The value of U was found to be 38 ± 2 kcal/mol which correlates better with data on other alloys and which is better than the previously reported value of 72 ± 5 kcal/mol. (TTT)

22539 AN INDICATED PHASE TRANSFORMATION NEAR ROOM TEMPERATURE IN YTTERBIUM. Kayser, F. X.; Soderquist, S. D. (Iowa State Univ., Ames). Scr. Met., 3: 259-61(Apr. 1969).

The electrical resistivity of four high purity, fcc ytterbium specimens was measured from 4.2 to 300°K. The data indicated the existence of a hysteresis. It is suggested that a martensitic crystallographic transformation occurred in each of the specimens upon cooling from 300°K. (G.M.C.)

22540 A NOTE ON COMPRESSION TESTING OF HIGH-PURITY NIOBIUM SINGLE CRYSTALS. Raghuram, A. C. (Univ. of Maryland, College Park); Armstrong, R. W.; Reed, R. E. Scr. Met., 3: 199-203(Apr. 1969).

High purity electron beam float zone refined niobium single crystals were compression tested at room temperature with strain rates of 1 to 4×10^{-4} sec^{-1}. Data are given that indicates the influence of specimen dimensions on crystal yield and work hardening behavior. It is suggested that height-to-diameter (h/d) ratio of 20 to 2.5 in rod-type specimens is most favorable for observing a well-defined stress-strain curve in compression of niobium crystals. (G.M.C.)

22541 COMMENTS ON DISLOCATION VELOCITY AND MACRO-DEFORMATION IN MOLYBDENUM. Vreeland, T. Jr.; Turner, A. P. L. (California Inst. of Tech., Pasadena). Scr. Met., 3: 193-4(Apr. 1969).

Evidence is presented to show that dislocation velocity in Mo as measured by Prekel, Lawley, and Conrad, NSA 22: 23836, does not fit the double kink model proposed by Seeger, [Phil. Mag. 1: 651(1956)]. It is noted that activation energies indicate that the strain rate relations in bcc materials are not independent of strain. (G.M.C.)

22542 LOW-CYCLE FATIGUE CRACK INITIATION IN Ti-6Al-4V. Wells, C. H.; Sullivan, C. P. (Pratt and Whitney Aircraft, Middletown, Conn.). ASM (Amer. Soc. Metals), Trans. Quart., 62: 263-70(Mar. 1969).

The mechanism of low-cycle fatigue crack initiation in Ti-6Al-4V was investigated at room temperature, in aqueous salt environment and at elevated temperatures. The rate of microcrack extension and linkup was not appreciably affected by temperature or environment. Surface microcracking occurred on the scale of the alpha phase particles primarily along slip bands, with some cracking along phase boundaries. Electrochemical measurements in salt water showed that microcracks formed at small fractions of lifetime and extended preferentially during the tension half of each cycle. Thin foil microscopy indicated dense tangles of dislocations resulting from cyclic deformation but provided no explanation of the observed cyclic strain softening behavior. (auth)

22543 STRAIN-RATE SENSITIVITY AS A MEASURE OF DUCTILITY. Woodford, D. A. (General Electric Co., Schenectady, N. Y.). ASM (Amer. Soc. Metals), Trans. Quart., 62: 291-3(Mar. 1969).

The strain rate sensitivity of materials showing varying elongation limits was measured. It was concluded that there is an unique correlation between the measured strain rate sensitivity and elongation under test conditions where strain hardening is negligible. It was suggested that due to uncertainty in elongation, the measured strain rate sensitivity was a more reliable measure of inherent ductility. (G.M.C.)

22544 RELATIVE LONG-TIME STABILITY OF CARBIDE AND INTERMETALLIC PHASES IN NICKEL-BASE SUPER-ALLOYS. Collins, H. E. (Thompson Ramo Wooldridge Inc., Cleveland). ASM (Amer. Soc. Metals), Trans. Quart., 62: 82-104(Mar. 1969).

Twelve nickel-base superalloys were examined utilizing microscopy and residue analysis techniques to identify and to determine the relative stability for long times (up to 5000 hours) of gamma-prime and the minor phases in the 1400 to 2100°F temperature range. The materials studied included seven cast alloys, IN 100, B-1900, Inco 713C, MAR-M200, MAR-M246, TRW-NASA IVY and TRW-NASA VIA, and five wrought alloys, U-700, René 41, Inconel 718, Waspaloy and Unitemp AF2-1D. Seven minor phases were identified: MC, $M_{23}C_6$, M_6C, M_3B_2, sigma, mu and Ni_3Nb. MC was found in all twelve alloys; $M_{23}C_6$ in all alloys except TRW-NASA IVY and Inconel 718; M_6C in B-1900, MAR-M200, MAR-M246, TRW-NASA VIA, René 41 and Unitemp AF2-1D; M_3B_2 in B-1900, Inco 713C, MAR-M200, MAR-M246, TRW-NASA IVY, TRW-NASA VIA and U-700; sigma in IN-100, Inco 713C, U-700, René 41 and Inconel 718; mu in René 41 and Unitemp AF2-1D; and Ni_3Nb in Inconel 718. Complete solutioning of gamma-prime did not occur in the seven cast alloys even at the highest exposure temperature studied, 2100°F. Complete solutioning of gamma-prime occurred for the wrought alloys in the following temperature ranges: 1800 to 1900°F for Waspaloy, 1900 to 2000°F for René 41 and 2000 to 2100°F for U-700 and Unitemp AF2-1D. Inconel 718 was an exception in that gamma-prime was not present at any of the temperatures studied after the long exposure times. (auth)

22545 STRUCTURE AND ELEVATED-TEMPERATURE MECHANICAL BEHAVIOR OF UNIDIRECTIONALLY SOLIDIFIED Ni–Ni_3Nb EUTECTIC ALLOY. Quinn, R. T.; Kraft, R. W.; Hertzberg, R. W. (Lehigh Univ., Bethlehem, Pa.). ASM (Amer. Soc. Metals), Trans. Quart., 62: 38-44(Mar. 1969).

An aligned structure of Ni_3Nb platelets in a matrix of α Ni was produced by unidirectional solidification of the Ni–Ni_3Nb eutectic alloy. Its crystallography was determined and hot hardness, hot tensile, creep-rupture, compression, and bend tests were used to investigate the mechanical properties. The test results prove conclusively that the unidirectionally solidified alloy is substantially strengthened parallel to the growth direction and that it behaves as a reinforced composite. The deformation and fracture modes of the aligned eutectic were examined. Slip was observed in both phases. In addition, in the Ni_3Nb phase, another type of deformation mechanism was observed. It is believed to be a manifestation of twinning and is associated with crack initiation. (auth)

22546 PRECIPITATION IN AN Fe–40 PERCENT Ni–6 PERCENT Nb ALLOY. Peard, K. A.; Borland, D. W. (Univ. of Melbourne). Scr. Met., 3: 267-9(Apr. 1969).

Preliminary results of the precipitation behavior of an Fe–40% Ni–6% Nb alloy are reported. Three precipitation phases appeared over a ten hour period when the alloy was aged at 775°C. (G.M.C.)

22547 CLOSED END BURST TESTING OF ZIRCALOY CANNING TUBES. Kaellstroem, O. Krister (Sandvik Steel Works, Sandviken, Sweden). J. Nucl. Mater., 31: 111-13(May 1969).

Two procedures for closed end burst testing of Zircaloy canning tubes were compared. One method implies deformation by pressing a liquid into a closed-end tube, while the other method comprises deformation by pressing liquid into the sample at a constant rate. A telescopic rod in the tube prevents bending. Constant deformation rate and straight tube sample promote homogeneous deformation and constant stress ratio which improve burst test results. (F.S.)

22548 CANNING MATERIALS FOR FAST REACTORS. Lagerberg, Goeran (Sandvik Steel Works, Sandviken, Sweden). 12p. of International Nuclear Power Day. Sandviken, Sweden, Sandvik Steel Works, 1968.

From Conference on International Nuclear Power Day, Sandviken, Sweden. See CONF-681124.

The behavior and requirements of canning materials for fast reactors are reviewed. The phenomena discussed are neutron absorption, transmutation, swelling due to He bubble formation, and He embrittlement. The materials considered are nickel alloys, stainless steels, and vanadium alloys. Data on the effects of irradiation on the creep-rupture properties of these materials are included. (L.C.L.)

22549 THE EFFECT OF OXYGEN ON THE MECHANICAL PROPERTIES AND STRUCTURE OF A TITANIUM ALLOY. Konstantinov, V. A.; Molchanova, E. K.; Zhabina, V. A. pp 257-60 of Metody Opredeleniya i Issled. Sostoyaniya Gazov v Met. Moscow, Nauka, 1968. (In Russian).

A study was made on the effect of O 0.15 to 0.35% on a Ti alloy containing Al 6.3, Mo 3.3, and Si 0.25%, with and without the addition of Zr 1.0%, after prolonged heating at 500°C. Increase in O content increased the strength and decreased the ductility and impact ductility with the Zr addition causing an even greater decrease in ductility. The addition of Zr to an alloy containing O retards the processes which tend to make the alloy of a uniform two-phase condition with high creep and ductility. The addition of 1.0% Zr to an alloy with 0.11% O raises the limit of endurance after 2000 hr at 500°C from 14.2 to 31.2 kg/mm^2 with residual deformation of 0.3 and 0.2%, respectively. (Referativnyi Zh.)

22550 URANIUM ALLOY. (to Commissariat a l'Energie Atomique). British Patent 1,149,728. Apr. 23, 1969. Priority date Jan. 13, 1967, France.

A uranium alloy primarily intended for fabrication of CO_2 cooled reactor fuel elements is described. The alloy has a microstructure of fine homogeneous alpha grains, low neutron cross section, improved creep rate and is radiation resistant. The alloy in addition to uranium contains 0.1% to 0.3% by weight of molybdenum and from 0.1% to 0.3% by weight in total of at least two additional metals selected from aluminum, chromium, and tin. (F.S.)

22551 STRESS RUPTURE PARAMETERS FOR THE REFRACTORY METALS. Conway, Joseph B. ASM Technical Report No. D8-3.4. Metals Park, Ohio, American Society for Metals, 1968. 23p.

Using optimization procedures, Larson–Miller constants were calculated for various refractory metals and refractory metal alloys. These constants were found to vary from 5.7 for a ternary W–Re–Mo alloy to about 10 for Ta–10W and about 20 for Mo-TZM. A summary plot is presented to provide a comparison of the parameter data for all the refractory metals and refractory metal alloys involved in this study. Also included in the present study are some Garofalo-type correlations in which the Larson–Miller and Dorn parameters for several refractory metals are expressed as hyperbolic sine functions of the stress. (Metals Abstr.)

22552 A STUDY OF POLYNARY URANIUM Mo–Zr–Nb–V ALLOYS. Tardif, H. P. Can. Mining Met. Bull., 61: 1289-1304(Nov. 1968).

Complex base alloy compositions were modified by varying the amount of alloying elements and by removing one or two of the alloying elements in turn from the base alloys. Uranium-base alloys were specially formulated in a search for heat treatable, high-strength, ductile, high-density alloys. All alloys studied were ternary, quaternary or more complex alloys of U with Mo, Zr, Nb, and V. Each cast alloy was studied under three different heat treatments, and its mechanical and corrosion properties were determined. It was found that although most of the alloys studied had the hardness and strength required, they were extremely brittle and notch-sensitive under tensile stresses. (Metals Abstr.)

22553 URANIUM ALLOY. (to Commissariat a l'Energie Atomique). British Patent 1,149,420. Apr. 23, 1969. Priority date Jan. 13, 1967, France.

A uranium alloy is described which is suitable for use in fabricating fuel elements for carbon dioxide gas cooled reactors. The alloy has fine and homogeneous alpha grains, low neutron capture cross section, and is creep and radiation resistant. The alloy is prepared by melting, casting, and in some cases heat treatment. The alloy contains 0.1 to 0.3 % by wt of molybdenum, from 0.1 to 0.3 % by wt of tin and the balance uranium. (F.S.)

22554 THERMAL CONDUCTIVITY OF SOME DELTA-PLUTONIUM ALLOYS. Andrew, J. F. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 30: 343-5(Apr. 1969).

Thermal conductivity of three stabilized delta plutonium alloys at 75 to 300°K was investigated. Face-centered cubic delta phase of unalloyed plutonium is stable at 315 to 450°C. Densities, electrical conductivity, and thermal conductivity for plutonium containing 3.35 and 7.0 at.% gallium and 10 at.% cerium are given. Data for thermal conductivities for the three alloys show smooth monotonic increase with temperature. Thermal conductivities are larger for alloys with higher electric conductivity. The proportion of the thermal conductivity attributed to lattice conduction varies from about 30% at room temperature to about 60% at 75°K. (F.S.)

Structure and Phase Studies

Refer also to abstracts 22484, 22534, 22539, 22544–22546, 22582, 22595, and 23291.

22555 (BNWL–790, pp 4.6-9) PREPARATION OF STAINLESS STEEL SINGLE CRYSTALS. Veeck, S. J.; Pfeifer, W. H. (Battelle Memorial Inst., Columbus, Ohio).

Techniques for preparing single crystals of Type 347 stainless steel are being investigated. The zone-melting method and equipment tried are described. The resulting samples were found to contain the ferrite phase, were polycrystalline, and had a significant chromium loss by evaporation, so further zone-melting work was discontinued. Controlled solidification by the Bridgeman technique was tried, and again the two samples obtained were polycrystalline and contained the ferrite phase, but the method is considered promising. Modifications such as the use of specially shaped Al_2O_3 crucibles and slower drop rates are recommended. Preliminary studies of strain anneal techniques for producing single crystals of Type 347 SS were initiated. (L.C.L.)

22556 (BNWL–790, pp 5.6-11) STAGE III RECOVERY IN NIOBIUM. Soo, P. (Brookhaven National Lab., Upton, N. Y.).

An analysis of research results on mechanisms involved in recovery of cold-worked Nb is presented. Data and information concerning substages I, II, and III are presented along with an analysis of jump frequencies and jump distances of point defects. (L.C.L.)

22557 (UCRL–18620) AN INVESTIGATION OF THE FACTORS AFFECTING THE FRACTURE CHARACTERISTICS OF CRACKED TUNGSTEN CRYSTALS. Key II, Paul Leland (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1969. Contract W-7405-eng-48. 118p. Dep. CFSTI.

Thesis.

The fracture of tungsten single crystals containing cracks of a known size and shape was investigated. Small cracks (about 150 μ deep) were introduced into tungsten single crystals of various crystallographic orientations by spark discharge. The tensile fracture behavior of these crystals was then evaluated at room temperature for both unannealed crystals and for crystals annealed in the range 1200 to 2400°C. The fracture of many of the cracked crystals required a sharp crack to be nucleated from the spark induced crack prior to fracture. The fracture behavior of these crystals was controlled by the crack nucleation processes. For other crystals, the spark crack could be directly propagated and a crack propagation criterion based on either a local or total strain energy release rate appeared to best describe the data. Fracture behavior of cracked tungsten crystals was significantly affected by annealing. At room temperature, the fracture surface energy decreased, then increased as the annealing temperature was increased and the opposite effect was observed at liquid nitrogen temperature. (auth)

22558 METHOD OF PROCESSING METASTABLE BETA TITANIUM ALLOY. Bomberger, Howard B. Jr.; Warmuth, Donald B. (to Reactive Metals, Inc.). U. S. Patent 3,436,277. Apr. 1, 1969. Filed July 8, 1966.

A method of processing a metastable beta titanium alloy which contains 0.8 to 1.8% aluminum, 7.5 to 8.5% vanadium, 4.5 to 5.5% iron and up to about 0.5% oxygen is described. The alloy is subject to a final hot-working at a temperature above its beta transus of about 1520°F. Thereafter it may be solution heat-treated, quenched, aged, or cold-worked and annealed. The method produces an improved microstructure and finer grain size over conventional practice of conducting the final hot-working at a temperature below the beta transus. (Offic. Gaz.)

22559 DATA ON THE VANADIUM–NICKEL EQUILIBRIUM DIAGRAM BETWEEN 0 AND 40 PERCENT NICKEL. Daire, M.; Gerspacher, M. (ENSCS, Strasbourg). J. Less-Common Metals, 17: 334-5(Mar. 1969). (In French).

The equilibrium diagram of Ni–V was studied between 0 and 40% Ni, using x rays, differential dilatometry, thermal analysis, micrography of tempered and annealed samples, and high temperature micrography. The results showed the juxtaposition of a solute region in solid β phase, of a zone where the σ phase is stable, and of a $\beta + \sigma$ phase. The body centered solid solution of nickel in vanadium is very broad and attains 23% of V at 1320°C and 8.7% at low temperature. The upper limit of the σ phase attains 72.5% V at low temperature and decreases to 64% with temperature increase. Thermal analysis and high temperature micrography showed the peritectic plateau of the $\beta + \sigma$ phase to be at 1325°C. The order-disorder transformation was observed at 620°C. (tr-auth)

22560 NATURE OF THE LOW-TEMPERATURE PHASE TRANSITION IN α–URANIUM. Meaden, G. T.; Size, N. H. (Dalhousie Univ., Halifax, Nova Scotia). Cryogenics, 8: 396-7(Dec. 1968).

A study was made of the formation of the low temperature phase and the dependence of the transition on impurities, cold working and annealing by means of resistivity and thermopower measurements. From the results it appeared likely that antiferromagnetism occurred in the $\alpha - U$ samples at low temperatures. It was not known to what extent impurities were responsible for this, but it was found that T_E was located near 60°K in the samples studied, compared with 43°K for certain samples of other authors, which suggests that it is possible that even pure $\alpha - U$ is antiferromagnetic below its $\alpha \rightleftharpoons \alpha_0$ transition temperature. (UK)

22561 EFFECT OF OXYGEN ON THE STRUCTURE AND PROPERTIES OF RHENIUM. Savitskii, E. M.; Tchuprikov, G. E. (Inst. of Metallurgy, Moscow). Met. Soc. Conf., 34: Pt. 1, 507-17(1968).

From Conference on High Refractory Metals, New York. See CONF-650227–(Pt.1).

Results indicate that oxygen has a more pronounced effect on the properties of Re than impurities such as Fe, W, and Mo. (J.R.D.)

22562 EFFECT OF GRAIN SIZE AND IMPURITIES ON TENSILE STRENGTH AND DUCTILITY OF TUNGSTEN FROM 2500 TO 5000°F IN VACUUM. Taylor, J. L. (California Inst. of Tech., Pasadena); Boone, D. H.; Simmons, O. W. Met. Soc. Conf., 34: Pt. 1, 491-505(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

The effect of grain size and impurity level on the tensile strength and ductility of powder-metallurgy tungsten was determined by comparing recrystallized coarse- and fine-grained undoped tungsten and recrystallized fine-grained doped tungsten. Tests were carried out in vacuum at a strain rate of 0.02/min from 2500 to 5000°F. Both fine-grained materials, about the same strength, were stronger than the coarse-grained. Ductility for the doped fine-grained tungsten (higher impurity level) was lower than for the undoped fine-grained tungsten in which stress-induced grain growth occurred more readily. Stress-induced grain growth correlates in a general way with ductility measured by either reduction in area or elongation. High and low values of stress-induced grain growth are associated with high and low values of ductility, respectively. In the intermediate temperature region between approximately 50 and 65% of the absolute melting point where a ductility minimum occurs, grain boundary sliding and its effects, void nucleation and growth and intercrystalline fracture, appear to predominate to lower ductility in both fine-grained materials. (auth)

22563 THE APW ENERGY BANDS FOR THE BODY CENTERED AND FACE CENTERED CUBIC MODIFICATIONS OF THE 3d TRANSITION METALS. Snow, E. C.; Waber, J. T. (Los Alamos Scientific Lab., N. Mex.). Acta Met., 17: 623-35 (May 1969).

Twenty-two sets of Augmented Plane Wave (APW) energy bands were computed for the 3d transition metals from titanium to copper. The unmodified version of Slater's exchange potential was used. The effects of crystal structure, atomic number, and assumed electronic configuration are isolated in this study because the bcc and fcc modifications of the elements as well as two general electronic configurations s^2d^n and s^1d^{n+1} were spanned. The computed character of the occupied bands favors an occupancy nearer to s^1d^{n+1} than to s^2d^n. The two-peak structure of the density of states N(E) curves which has been deduced from an experimental study of the electronic specific heats of alloys is clearly resolved in the present N(E) curves for only a limited set of conditions. (auth)

22564 AN INVESTIGATION OF THE ABSORPTION AND THE DIFFUSION OF GASES IN PALLADIUM METAL AND ZIRCONIUM–IRON ALLOY USING FLUORESCENT AND MOESSBAUER TECHNIQUES. De John, Charles Samuel. Houston, Tex., Univ. of Houston, 1968. 127p.

Thesis.

The absorption and diffusion of gases in Pd metal and Zr–Fe alloy were investigated using fluorescent and Moessbauer techniques. A H gas discharge experiment demonstrated silver activated ZnS and ZnCdS lumophors were caused to luminesce by the 4.76 eV of energy released by each pair of hydrogen atoms recombining at the lumophor's surface. The sensitivity of the detectors required a minimum of 4.6 × 10^6 atomic H recombinations/sec at the lumophor's surface. The lumophors were used to search for atomic H in a hydrogen gas stream after the gas had diffused through a Pd tube. The tube was heated from 90 to 500°C and the pressure on the entrance side varied from one to one and one-half atmospheres. No luminescence was observed indicating that the maximum fraction of atomic H present was 7.6 × 10^{-9}. The conclusion is that hydrogen desorbed as molecules from the metal surface. Two Zr–Fe alloys were prepared and were identical except in the duration of annealing. The alloy annealed for 12 hours was denoted A and a ½ in. × ½ in. piece cut from A was denoted A-1; the alloy annealed for 6 hours was denoted B. X-ray analysis of A and B revealed that both were comprised of three intermetallic phases, viz., α, a hexagonal close-packed structure, ρ (Zr_4Fe), and ϕ (Zr_2Fe). Measurements revealed that A possessed a larger amount of the ρ phase but smaller amounts of the α and ϕ phases than B. Comparison of Moessbauer measurements using A-1 as an absorber at 4.2, 77, and 298°K with similar measurements or A and B at 298°K indicated each absorber had a fourteen line spectrum. Six of the lines corresponded to the ρ phase and represented a magnetic field $H_\rho = -330 \pm 3$ kOe. No appreciable quadrupole interaction or isomer shift relative to Fe was observed. The spectra also revealed that the six lines characterizing the ρ phase were much more intense for A and A-1 than for B. Six more lines were deduced from a theoretical, calculated fit to the experimental data of A-1 to correspond to the ϕ phase. This subspectrum represented: a magnetic field $H_\phi = -160 \pm 3$ kOe, a vertical component of the electrical field gradient tensor V_{zz} = 7.21 × 10^{16} statvolts/cm², an asymmetry parameter $\eta = 0.60$, and an isomer shift $\delta_\phi = 0.0962 \pm 0.0392$ mm/sec. The remaining two lines comprised a quadrupole splitting and corresponded to the α phase. The splitting energy $\Delta E_Q = 4.32 \pm 0.19 \times 10^{-8}$ eV and the isomer shift $\delta_\alpha = 0.34 \pm 0.08$ mm/sec. The spectra also showed that these two lines were much more intense in B than in A. It was also found that spectra of A-1 taken two months after a spectrum of A exhibited more intense peaks than A. This was attributed to the absorption of oxygen from the atmosphere by A-1. Upon absorption of 7.99 wt % O, A-1 revealed a twenty-six line spectrum. Measurements from 4.2 to 873°K were made and indicated a twenty-six line spectrum. These lines corresponded to Fe_3O_4 (12), Fe_2O_3 (6), the ρ phase (6), and the α phase (2). The measurement at 873°K indicated an average field of −269 kOe. The spectrum at 298°K following the 873°K measurement indicated that only eight lines were present and corresponded to Fe_2O_3 and the α phase. Areas of future research are discussed pertaining to the absorption of O, the formation of Fe_3O_4, and the measurements of single phase alloys. (Diss. Abstr.)

22565 INVESTIGATION OF ALLOYS IN THE Nb–Ar–Cr SYSTEM. Savel'eva, M. M.; Grum-Grzhimailo, N. V. Izv. Akad. Nauk SSSR, Metal., No. 1, 224-8(Jan.-Feb. 1969). (In Russian).

The melting diagram for the system Nb–Zr–Cr was constructed for the section containing $ZrCr_2$–$NbCr_2$. The isothermal sections of the system were constructed at 1200 and 1000°C with the aid of microstructural and x-ray phase analyses. It was found that lowering the temperature narrowed the γ and β fields insignificantly. (tr-auth)

22566 ELECTRON-MICROSCOPIC AND X-RAY STUDIES OF ANNEALED Ti–25 AT. PERCENT Nb. Sudareva, S. V.; Buinov, N. N.; Rakin, V. G. (Inst. of Physics of Metals, Moscow). Fiz. Metal. Metalloved., 26: 781-8(Nov. 1968). (In Russian).

X-rays and electron microscopy were used for determining the structure of Ti–25 at. % Nb alloys annealed in a vacuum at 1100°C for 5 hr. The data on the crystalline structure revealed the shape of particles, their orientation in the matrix, and the geometry of intensity fields near particles in the ω phase. A β^* phase with a monoclinic lattice was also observed. (R.V.J.)

22567 AUTOELECTRON EMISSION AND STRUCTURE OF Mo–Re ALLOY SURFACE IN THE α- AND β-PHASE REGION. Kuznetsov, V. A. (Moscow Physical-Technical Inst.). Fiz. Metal. Metalloved., 26: 803-9(Nov. 1968). (In Russian).

Emission and kinetics of Mo–47 wt % Re transformation were studied in the α- and β phase regions. Data obtained showed an intense segregation of Mo on the surface of the alloy at 2300°K. (R.V.J.)

22568 STRUCTURE AND PROPERTIES OF Ni_3Al (γ') EUTECTIC ALLOYS PRODUCED BY UNIDIRECTIONAL SOLIDIFICATION. Thompson, E. R.; Lemkey, F. D. (United Aircraft Research Labs., East Hartford, Conn.). ASM (Amer. Soc. Metals), Trans. Quart., 62: 140-54(Mar. 1969).

The composition, structure, and properties of three unidirectionally solidified eutectics within the Ni–Al–Nb, Ni–Al–Zr, and Ni–Al–Ti systems were determined. The eutectic phases in the respective systems consisted of $Ni_3Al(\gamma')$ with Ni_3Nb, with Ni_7Zr_2, and with Ni_2TiAl and Ni_3Ti. The eutectic phases grew as alternate lamellae aligned parallel to the direction of solidification. The crystallographies of the pseudo-binary systems were determined by transmission electron metallography. Lamellae in the Ni_3Al–Ni_3Nb and Ni_3Al–Ni_7Zr_2 eutectics exhibited preferred interface planes. This observation was interpreted geometrically as minimizing misfit strain in agreement with that predicted. The microhardness of the eutectic constituents, compressive properties at room temperature, and tensile strength at 2000°F were measured in each eutectic system. The mechanical properties of the Ni_3Al–Ni_3Nb eutectic were characterized most completely. Its longitudinal hot strength in tension and creep was found to be superior to all advanced nickel base superalloys. This investigation demonstrated that useful properties may be developed by reinforcing the strong and ductile gamma prime phase by an intermetallic compound having greater strength at elevated temperature. The oxidation products of each eutectic were identified by x-ray diffraction. Because of the spalling nature of the oxides, it was concluded that a protective coating would be necessary for extended use of these materials at elevated temperatures. (auth)

22569 $(W_{0.35}V_{0.65})_2O_5$, A NEW, SIMPLE BLOCK STRUCTURE. Israelsson, Mats; Kihlborg, Lars (Univ. of Stockholm). Ark. Kem., 30: 129-40(1969).

The crystal structure of the phase $(W_{0.35}V_{0.65})_2O_5$ was determined and refined from diffractometer data. The dimensions of the tetragonal unit cell are a = 19.506 Å, c = 3.7039 Å. The space group is I4/mmm. The structure can be described as a block-type with ReO_3-type blocks 4 × 4 × ∞ octahedra in size coupled together by edge-sharing between component octahedra. It may formally be derived from an ReO_3-type arrangement by a shear mechanism along two sets of planes which are perpendicular to each other. Further hypothetical homologous structures are proposed, forming together a two-dimensional homologous series. The geometrical relationship with the structure of NNb_2O_5 is discussed. The structure may also be regarded as composed of three types of structural elements resembling those which are uniquely found in WO_3, $CoMoO_4$, and the monoclinic, high-temperature form of the present phase. The W and V atoms are disordered but with different W/V ratios in different positions. (Sweden)

22570 TRANSFORMATION IN URANIUM–0.45 PERCENT MOLYBDENUM ALLOY IN RELATION TO COOLING RATES AND OVERHEATING TEMPERATURE. Mihajlovic, A.; Kostic, M.; Tepavac, P. (Boris Kidric Inst. for Nuclear Sciences, Belgrade). J. Nucl. Mater., 31: 107-10(May 1969).

The kinetics of transformation in uranium alloy with 0.45 wt % molybdenum cooled at rates of 2°C/sec to 80°C/sec from 720, 700, 690, 680, and 670 were studied. The change in the microstructure with the change in overheating temperature and cooling rate are presented in a T_t diagram. A change in the mechanism of transformation as a function of the cooling rate was observed. Lower temperatures of overheating did not accelerate the transformation. Metastable β-phase retained by cooling from lower β-temperatures transformed α^1 faster than β-phase from higher β-temperature. (F.S.)

22571 GRAPHICAL INTERPRETATION OF THE STRUCTURE FACTORS OF SUPERLATTICES. LeFevre, B. G.; Starke, E. A. Jr.; Spooner, S. (Georgia Inst. of Tech., Atlanta). Surface Sci., 14: 266-9(Mar. 1969).

For indexing of field-ion micrographs, the utility of interpreting diffraction phenomena and structure analysis is shown for ordering alloys in terms of atomic planes. The analysis applies for the first-order superlattice reflections for alloys which change from a Bravais lattice having one atom per lattice point in the disordered state to one having more than one atom per lattice point in the ordered state. The graphical approach is applied to Ni_4Mo; structure factors are derived for the superlattice and fundamental reflections. (D.L.C.)

22572 PRE $\alpha \rightarrow \beta$ TRANSFORMATION IN HIGH PURITY PLUTONIUM. Harbur, D. R.; Anderson, J. W.; Maraman, W. J. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 30: 289-96(Apr. 1969).

The small thermal effect which has been detected on heating just below the α-β equilibrium temperature of plutonium by differential thermal analysis has been interpreted previously as being caused by an endothermic reaction. Experiments involving the thermal, electrical and physical properties of high purity plutonium were conducted which show that the small thermal effect just prior to the α-β equilibrium transformation temperature is caused by the exothermic transformation of retained γ to α phase which becomes inoperative above the reported pre $\alpha \rightarrow \beta$ temperatures. The pre $\alpha \rightarrow \beta$ phenomenon in high purity plutonium can be increased with thermal histories that increase the retention of γ phase plutonium and conversely the effect can be eliminated by first transforming the metastable higher temperature phases to α phase plutonium. (auth)

22573 PLUTONIUM–ZIRCONIUM EQUILIBRIUM DIAGRAM FROM 0 TO 10 AT PERCENT Zr. Taylor, J. M. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater., 30: 346-50(Apr. 1969).

A portion of the plutonium–zirconium phase diagram from 0 to 10 at.% Zr was investigated for alloys prepared by arc melting weighted amounts of plutonium and zirconium on a water-cooled copper hearth in an argon atmosphere to produce buttons. The buttons were melted in a vacuum induction furnace to form ingots from which specimens were analyzed by x-ray and metallography after heat treatments. Phase diagrams indicate that the ζ phase does exist. (F.S.)

22574 X-RAY INVESTIGATION OF THE MONOCLINIC DEFORMATION OF THE α URANIUM LATTICE IN THE U–Nb SYSTEM. Malcic, S.; Mihajlovic, A.; Mance, A.; Tepavac, P. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Nucl. Mater., 30: 314-18(Apr. 1969).

The course of monoclinization was followed by the changes of line breadth ratios for the (112) and (131) diffraction peaks of α-uranium. The results suggest that the so-called α'_b-phase actually represents the period from the beginning of the lattice monoclinization up to the moment when splitting of the lines becomes visible on x-ray photographs. Therefore it seems unjustified to consider α'_b as a separate phase. The boundary between the orthorhombic (α') and monoclinic (α'') phase is found at a concentration of ≈3 wt % Nb for both quenching rates. (auth)

22575 HYDRIDE ORIENTATION IN ZIRCALOY TUBES IN RELATION TO DEFORMATION, TEXTURE, AND STRESS. Schelzke, E. (Metall-Laboratorium der Metallgesellschaft AG, Frankfurt am Main). J. Nucl. Mater., 30: 324-36(Apr. 1969). (In German).

A relationship was established between texture, stresses, and hydride orientation in zircaloy tubes. It was established that the lamellar precipitates of zirconium hydride arranged themselves within a limited angular range which depends on the texture. This angular range can be regarded as an orientation range for the habit planes of the zirconium hydride precipitates and encompasses positions in the unit triangle of α zirconium within a range of 5 to 20° from the [0001] pole of n zirconium. The orientation of precipitates by means of stresses is only possible within this angular range. (auth)

Radiation Effects

Refer also to abstracts 21893, 22464, 22548, and 23849–23856.

22576 (AECL-3226) STRAIN CAUSED BY RECOVERY OF RADIATION DAMAGE IN A ZIRCALOY PRESSURE TUBE. Piercy, G. R.; Lori, J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Dec. 1968. 10p. Dep. CFSTI. CAN $0.50.

The circumferential strain of rings cut from cold worked Zircaloy-2 pressure tubes after irradiation to 9.7×10^{20} n/cm^2 >1 MeV was compared with that of annealed rings during heating to 400°C. A circumferential strain of less than 10% of the creep strain produced during irradiation, was caused by the anneal. This eliminates the possibility of the main component of the in-reactor creep being caused by the preferred alignment of those small dislocation loops which anneal at 400°C. (auth)

22577 (AI-AEC-12744, pp 65-78) MATERIALS MANAGEMENT. Kramer, D. (Atomics International, Canoga Park, Calif.).

Tensile testing of 304L stainless steel samples ANL was completed. Data from these tests are included along with data from stress-rupture testing of 304 stainless steel and tensile tests of Incoloy 800 containing Al and Ti at 700°C. Previously reported tensile data on 405 stainless steel are also included along with data on composition and tensile properties of 19-9 DL stainless steel. (J.R.D.)

22578 (AI-AEC-12744, pp 123-8) MIXED CARBIDE FUELS (IRRADIATION STUDIES). Ervin, G. Jr. (Atomics International, Canoga Park, Calif.).

The irradiation experiment NRX-101 was terminated and the fuel slugs of uranium carbide disassembled. The effectiveness of fine dispersion tungsten doping is shown by improvement in the high temperature irradiation stability of UC. The fine particle dispersions control fission gas swelling. Density measurements on the slugs have begun. (J.C.W.)

22579 (AI-AEC-12744, pp 169-78) RADIATION DAMAGE IN CRYSTALLINE SOLIDS. Bauer, W.; Keefer, D. W.; Neely, H. H.; Sosin, A.; Thommen, K. H.; Vawter, D. D. (Atomics International, Canoga Park, Calif.).

Discussions of data which bear on two recovery models for near room temperature recovery of electron irradiated Al are presented. Data on the resistivity recovery of electron-irradiated Ti are also discussed along with results of experiments on low-temperature electron displacement of Au atoms. Progress in an investigation of recovery by electron irradiated Zr is reported. Investigations of electron effects on doped and undoped GaSb and GaAs are described along with progress in experiments devoted to electron-induced dislocation pinning in Cu and Ag. (J.R.D.)

22580 (ANL-Trans-736) ON THE THEORY OF SWELLING. August, M. Translated for Argonne National Lab., Ill., from Kernenergie, 11: 186-90(1968). 16p. Dep. CFSTI.

The swelling model of Barnes assumes that gas bubbles of only one size are present at any one time. The present study dispenses with this limiting hypothesis and offers a representation in which the bubble spectrum is taken into account. A nonlinear integrodifferential equation is derived for the bubble distribution function and is transformed into an ordinary infinite system of differential equations. An analytical representation can be found for the quantity of swelling which is based on the solution of the system of differential equations as obtained by numerical integration. The expression of Barnes for the asymptotic time behavior of isothermal postirradiation swelling is confirmed. (auth)

22581 (APED-5490) MODIFIED SURVEILLANCE PROGRAM FOR GENERAL ELECTRIC BWR PRESSURE VESSEL STEELS. Higgins, J. P. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). May 1967. 43p. (67-APE-2).

Specimen geometry, capsule design, associated equipment, material selection, and techniques for special preparation and testing, used in pressure vessel steel surveillance programs for BWR power plants are described. (auth)

22582 (BNWL-790) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, February-April 1968. Claudson, T. T. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1968. Contract AT-(45-1)-1830. 206p. Dep. CFSTI.

Eighteen sections on investigations of the effects of irradiation on reactor structural materials are presented. A separate abstract was prepared for each of 18 sections. The section for which no abstract was prepared contained no useful information. (L.C.L.)

For abstracts of individual sections see: 21910, 22513, 22514, 22555, 22556, and 22583–22595.

22583 (BNWL-790, pp 3.1-8) EFFECTS OF IRRADIATION ON THE MECHANICAL PROPERTIES OF FAST REACTOR CLADDING MATERIALS. Carlander, R. (Argonne National Lab., Ill.).

The effects of fast neutron irradiation on the mechanical properties of Hastelloy X, Inconel 625, stainless steel Type 304, and vanadium alloys were measured at 400 to 750°C and fluences up to 1×10^{23}. Tube burst tests conducted at 550°C on irradiated and unirradiated specimens showed that: the rupture strength of all the alloys increased as a result of irradiation; the circumferential ductilities of the Cr–Ti–V alloy, Inconel 625, and Type 304 SS increased as a result of irradiation to fluences of less than 1×10^{21}; and, at higher fluences, the circumferential ductility of the alloys, including Hastelloy X, decreased. Post irradiation tensile tests on vanadium alloys conducted at 400 to 750°C showed there is a significant increase in yield strength due to irradiation at test temperatures below 650°C. At 750°C the irradiated and unirradiated yield strengths are approximately the same. Increase in fluence did not appear to result in higher irradiation yield strength. Creep tests at 650°C showed that irradiation had no effect on the creep properties of V-20Ti. (L.C.L.)

22584 (BNWL-790, pp 3.9-10) VOIDS IN EBR-II CLADDING AND CONTROL ROD SHROUD. Harkness, S. D. Argonne National Lab., Ill.).

EBR-II Mark 1 A fuel cladding sections, which had been stressed by high swelling fuel and irradiated to 1.4×10^{22} n/cm^2, were examined by transmission electron microscopy to determine void density, size, and volume fraction. Also, sections of a Type 304 SS control rod shroud, which were unstressed during exposure, were irradiated in the EBR-II at a peak fluence of 5×10^{22} n/cm^2 and examined for void characteristics. The comparison indicated that stress is unimportant to the phenomenon of void formation. (L.C.L.)

22585 (BNWL-790, pp 4.1-6) EFFECT OF RADIATION ON THE MECHANICAL PROPERTIES OF CLADDING MATERIALS. Kangilaski, M.; Peterson, S. L.; Perrin, J. S.; Wullaert, R. A. (Battelle Memorial Inst., Columbus, Ohio).

The extent and nature of the radioinduced changes in the mechanical properties of Type 347 SS and other potential cladding materials for liquid-metal-cooled fast reactor applications are being investigated. Tensile tests were performed on irradiated specimens of Haynes Stellite 25, Tenelon, and UMCo-50 to determine the role of nickel on radioinduced embrittlement at 450, 550, and 650°C. The results indicate that irradiation causes severe embrittlement in all three materials at test temperatures of 550°C and above, whereas at 450°C, irradiation does not affect the tensile properties of UMCo-50, but decreases both the strength and ductility of Haynes Stellite 25 and Tenelon. Stress-rupture tests at 650°C on Type 347 SS irradiated at 2.2×10^{22} n/cm^2 showed that irradiation causes a significant reduction in rupture time (from approximately 1700 to 1200 hrs). (L.C.L.)

22586 (BNWL-790, pp 4.10-11) CORRELATION OF RADIATION EFFECTS ON MECHANICAL PROPERTIES AS CAUSED BY A PREDOMINANTLY FAST FLUX AND A MIXED FAST AND THERMAL FLUX. Kangilaski, M.; Perrin, J. S.; Wullaert, R. A. (Battelle Memorial Inst., Columbus, Ohio).

22587 (BNWL-790, pp 4.12-15) DETERMINATION OF THE FRACTURE TOUGHNESS OF SPECIMENS FROM THE PM-2A PRESSURE VESSEL. DeMastry, J. A.; Sheckherd, J. W.; Wullaert, R. A. (Battelle Memorial Inst., Columbus, Ohio).

The fracture toughness of irradiated pressure vessel materials is being investigated using wedge-opening-loading (WOL) specimens machined from the PM-2A pressure vessel and which are either fatigue cracked or slotted by electrodischarge machining (EDM). The fatigue cracking of unirradiated control specimens PM-2A WOL was completed, and cracks approximately $1/8$ in. deep were achieved after cycling between 700 to 2100 lb for 10^6 cycles. Fatigue cracking of the irradiated samples was initiated, and two specimens were tensile tested to failure at − 20°F. (L.C.L.)

22588 (BNWL-790, pp 5.1-4) EFFECT OF IRRADIATION ON PROPERTIES OF COBALT BASE ALLOYS. Chow, J. G. Y. (Brookhaven National Lab., Upton, N. Y.).

Test data are presented on the tensile properties of commercially available and experimentally promising cobalt-base alloys irradiated below 100°C to a fluence of 1.3×10^{20}, solution heat treated for 15 minutes at 1175°C, and tested at 25, 650, 750, and 800°C. All the irradiated alloys showed loss of ductility with increasing testing temperature. Data on irradiated Haynes 25 and UMCO-51 are compared with those for irradiated Type 304 SS. The cobalt alloys were at least equal to Type 304 SS in elevated temperature ductility and had twice the strength of Type 304 SS at 650°C. The possibility of improving the post-irradiation ductility of the cobalt alloys by changes in the heat treatment is suggested. (L.C.L.)

22589 (BNWL-790, pp 5.4-6) EFFECT OF MICROSTRUCTURE ON THE ELEVATED TEMPERATURE DUCTILITY OF STAINLESS STEELS. Chow, J. G. Y. (Brookhaven National Lab., Upton, N. Y.).

The effects of microstructure changes on the ductility of Type 304 SS were studied by comparing the tensile properties of unirradiated and irradiated (1.3×10^{20} fluence) specimens which had been subjected to different annealing and working conditions and which were tensile tested at temperatures from 25 to 800°C. The treatments included annealing at 1050°C; and combinations of single or repeated 18% deformation at 77°K plus 16 hrs of annealing at specified temperatures from 650 to 815°C. For all conditions, there was a severe drop in the irradiated steel ductility at test temperatures above 500°C with a slight recovery between 700 to 750°C. A single deformation at 77°K followed by annealing resulted in only a nominal improvement in ductility over that for annealed Type 304 SS. However, for test temperatures from 650 to 800°C, a treatment of 18% deformation at 77°K plus annealing at 705°C plus 18% deformation again at 77°K and 16 hrs annealing at 760°C resulted in materials which had twice the post-irradiation ductility of 1050°C annealed Type 304 SS. It is concluded that further refinement of the microstructure might produce additional improvement in elevated temperature ductility after irradiation. (L.C.L.)

22590 (BNWL-790, pp 5.11-13) RADIATION HARDENING IN TUNGSTEN. Galligan, J. M. (Brookhaven National Lab., Upton, N. Y.).

The effect of fast neutron irradiation on the Critical Resolved Shear Stress (CRSS) of pure single crystals of tungsten, and the effect of annealing on the temperature dependence of CRSS in irradiated tungsten were examined. The results showed that the temperature dependence of irradiated tungsten is not the same as unirradiated tungsten, and that after irradiated specimens are annealed at a temperature above Stage III, the temperature dependence of the yield stress is again changed and is more steep than that for either the annealed or as-irradiated crystals. (L.C.L.)

22591 (BNWL-790, pp 7.1-7) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Beeston, J. M.; Brinkman, C. R. (Idaho Nuclear Corp., Idaho Falls).

Hydrogen embrittlement of steels is being investigated. Progress is reported on: study of the behavior of hydrogen during the electrolytic charging of irradiated samples; development of procedures for controlling the hydrogen content and its distribution within a charged metal specimen; materials testing of tensile specimens of preirradiated Types A302B and HY-80 steels to determine the effect of hydrogen content on the time of rupture; plans for hydrogen permeability measurements; and the encapsulation of samples for irradiation. The investigation to determine the high temperature unaxial fatigue properties of steel Types A302B, HY-80, 316 SS, 304 SS, 304L, and Incoloy 800 is continuing, and the encapsulation of specimens into two subassemblies for irradiation in the EBR-II has been completed. (L.C.L.)

22592 (BNWL-790, pp 9.1-20) RESEARCH PROGRESS. Steele, L. E.; Hawthorne, J. R.; Serpan, C. Z. Jr.; Potapovs, Uldis (Naval Research Lab., Washington, D. C.).

Investigations of radiation effects on pressure vessel materials were conducted. The effects of weld filler composition on the radioinduced embrittlement of Cr–Mo–Ni metals for welding Type A543 steel were investigated. Test data demonstrated that sensitivity of weld metals to radioinduced embrittlement can be reduced by reducing the copper content of the weld deposit. The effect of prior heat treatment on the radioinduced embrittlement of Cr–Mo–Ni steel plate was studied. Results showed that prior temperature embrittlement has no effect on the apparent radioinduced embrittlement sensitivity of the material at exposure temperatures to 750°C. An examination of the effect of irradiation at 550°F on the notch ductility properties of materials in and near a 7½ in. production weldment of Type A533B steel revealed that the weld metal was more affected by irradiation than the base plate or the heat affected zone and that the weldment copper content contributed to this. The Charpy-V energy absorption levels in 6⅜ in. A533B Class I and II steel plate were measured, and it was concluded that the Charpy-V-30-ft-lb energy absorption level used as an index of the NDT of Type 302B pressure vessel steel cannot be applied to this material. The mechanical properties of PM-2A reactor pressure vessel steel were evaluated. Annealing results showed that essentially 100% recovery of pre-irradiation notch ductility properties can be achieved by post-irradiation annealing for 168 hr at 650°F followed by reannealing for 168 hr at 750°F. Tensile tests showed no significant effect of irradiation on area reduction and elongation of test specimens, but yield and tensile strengths increased with neutron exposure. Neutron dosimetry data were obtained. The yield stress of actual irradiated-condition PM-2A steel was higher than that for the unirradiated condition which is commonly used for assessing safety margins, which means that the overall safety of the reactor is increased. (L.C.L.)

22593 (BNWL-790, pp 10.1-10) RADIATION EFFECTS ON FAST REACTOR CLADDING AND STRUCTURAL MATERIALS. Moteff, J. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The effects of irradiation (EBR-II, 0.27 and 2.7 × 10^{20} n/cm^2, E > 1 MeV at about 540°C) on the postirradiation creep-rupture properties of Incoloy 800 at 540 and 704°C are presented. Multiple stress tests in which one specimen is used to generate a stress-creep rate curve is discussed. Preliminary results on the influence of low neutron fluence (3 × 10^{18} n/cm^2, E > 1 MeV) irradiations at reactor ambient temperature on the 650°C plastic fatigue properties of Type 316 SS are presented. (auth)

22594 (BNWL-790, pp 11.1-13) RADIATION EFFECTS IN FUEL CLADDING MATERIALS. (Oak Ridge National Lab., Tenn.).

EXPERIMENTAL BREEDER REACTOR-II—structural materials for, method for conducting irradiation experiments on
HEAT TREATMENT—effects on creep-rupture properties of Type 304 SS and titanium-modified Type 304L SS
NEUTRONS, FAST—effects on creep-rupture properties of titanium-modified Types 304 and 304L SS at 704°C
—effects on mechanical properties of regular and titanium-modified Type 316 SS at 550 to 750°C
NEUTRONS, THERMAL—effects on mechanical properties of regular and titanium-modified Type 316 SS at 550 to 750°C
STAINLESS STEEL—radiation effects on creep-rupture properties of titanium-modified Types 304 and 304L, at 704°C, fast neutron
—creep-rupture properties of Type 304 and titanium-modified Type 304L, effects of heat treatment on
—tubes of titanium-modified low-carbon grade Type 304, methods for fabricating
—radiation effects on mechanical properties of regular and titanium-modified Type 316, at 550 to 750°C, fast and thermal neutron
TUBES—fabrication of titanium-modified low-carbon grade Type 304 SS, methods for (L.C.L.)

22595 (BNWL-790, pp 12.1-66) IRRADIATION DAMAGE TO REACTOR METALS. Bement, A. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

AMMONIUM HYDROXIDE—corrosive and hydriding effects on Zircaloy-2, research on
ANNEALING—effects of post-testing high temperature, on microstructure of irradiated Type 304 SS
—effects of high pressure-temperature, on microstructure of irradiated Type 304
—effects of post-irradiation, on the microstructure of carbon-containing molybdenum
DEUTERIUM—effusion characteristics for Types 316 and 348 SS, temperature dependence of
HASTELLOY F—tensile properties at 704°C, effects of pretest thermal aging on
—radiation effects on tensile properties of, at 704°C, mixed fast and thermal neutron
HASTELLOY X—radiation effects on tensile properties of, fast neutron, research on heat treatment and flux dependence of
HEAT TREATMENT—effects of pretest, on tensile properties of nickel-base alloys at 704°C
HELIUM—effects on grain growth characteristics of powdered nickel, research on
INCOLOY 801—tensile properties at 704°C, effects of pretest thermal aging on
—radiation effects on tensile properties of, at 704°C, mixed fast and thermal neutron
INCOLOY 804—tensile properties at 704°C, effects of pretest thermal aging on
—radiation effects on tensile properties, at 704°C, mixed fast and thermal neutron
INCOLOY 825—tensile properties at 704°C, effects of pretest thermal aging on
—radiation effects on tensile properties of, at 704°C, mixed fast and thermal neutron
INCONEL 600—radiation effects on tensile properties of, fast neutron, research on heat treatment and flux dependence of
INCONEL 718—tensile properties at 704°C, effects of pretest thermal aging on
—radiation effects on tensile properties of, at 704°C, mixed fast and thermal neutron
INCONEL X-750—radiation effects on tensile properties of, relations of heat treatment and flux intensity with fast neutron
IRRADIATION FACILITIES—operation of reactor structural material testing
LITHIUM HYDROXIDES—corrosive and hydriding effects on Zircaloy-2, research on
MATERIALS TESTING—fracture toughness of Type A533 SS, effect of DCB specimen size on
MOLYBDENUM—microstructure of carbon-containing, effects of post-irradiation annealing on
—electrical resistance of irradiated high-purity, effects of hydrostatic pressure on isochronal recovery of
NEUTRONS, FAST—effects of mixed thermal and, on the tensile properties of nickel-base alloys at 704°C
—effects on tensile properties of annealed Type 348 SS, test temperature dependence of
—effects on tensile properties of double-aged Type AM-350 SS, test temperature dependence of
—effects on tensile properties of martensitic Type 410 SS at room temperature and 600°C, flux dependence of
—effects on tensile properties of martensitic Type 410 SS, test temperature dependence of
—effects on creep of Type 304 SS at 450°C
—effects on creep of Zircaloy-2 at 315°C
—effects on creep of niobium-zirconium alloy at 315°C
NEUTRONS, THERMAL—effects of mixed fast and, on the tensile properties of nickel-base alloys at 704°C
NICKEL—grain growth characteristics of helium-containing powdered, research on
—microstructure of high-purity, irradiated at 400°C
—X-ray scattering in high-purity, effect of irradiation-produced voids on
NIOBIUM A & S—Nb–Zr, radiation effects on creep of, at 315°C, fast neutron
PRESSURE VESSELS—steels for, research on crack propagation in heavy section
RENE-62—tensile properties at 704°C, effects of pretest thermal aging on
—radiation effects on tensile properties of, at 704°C, mixed fast and thermal neutron
RHENIUM—microstructure of, irradiated at 550°C
STAINLESS STEEL—radiation effects on tensile properties of annealed Type 348, fast neutron, test temperature dependence of
—radiation effects on tensile properties of double-aged Type AM-350, fast neutron, test temperature dependence of
—radiation effects on tensile properties of martensitic Type 410, at room temperature and 600°C, flux dependence of
—radiation effects on tensile properties of martensitic Type 410, fast neutron, test temperature dependence of
—microstructure of irradiated Type 304, tested at 750°C, effects of post-testing annealing temperatures on
—radiation effects on creep of Type 304, at 450°C, fast neutron
—microstructure of irradiated Type 304, effects of high pressure-temperature annealing on
—deuterium effusion characteristics for Types 316 and 348, temperature dependence of

  —density and swelling of irradiated annealed Types 304, 304L, and 316
  —tubes of Types 304 and 316, microstructure and room temperature tensile properties of
  —creep of Type 304, at 1200°F in air
STEEL—crack propagation in heavy section reactor pressure vessel, research on
  —fracture toughness of Type A533B, effect of DCB specimen size on
TEMPERATURE—effects of test, on tensile properties of annealed unirradiated and fast neutron irradiated Type 348 SS
  —effects of test, on tensile properties of double-aged unirradiated and fast neutron irradiated Type AM-350 SS
  —effects of test, on tensile properties of irradiated and unirradiated martensitic Type 410 SS
  —effects of post-test annealing, on microstructure of irradiated Type 304 SS
  —effects on deuterium effusion characteristics for Types 316 and 348 SS
TUBES—microstructure and room temperature tensile properties of Types 304 and 316 SS fuel cladding
ZIRCALOY-2—radiation effects on creep of, at 315°C, fast neutron
  —corrosion and hydriding by pH-10 ammonium hydroxide and lithium hydroxide, effects of pre-filming on
ZIRCONIUM A & S—Nb–Zr, radiation effects on creep of, at 315°C, fast neutron (L.C.L.)

22596 (KAPL-3440) POST-IRRADIATION AND CO-IRRADIATION ANNEALING OF IRON AND STEEL. Powers, A. E. (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 1968. Contract W-31-109-eng-52. 34p. Dep. CFSTI.

Discussions are presented on thermodynamic theory of post-irradiation and co-irradiation annealing and the application of annealing data to the accurate prediction of changes in mechanical properties during long-time irradiation of iron and steel at temperatures over 400°F. The basic equation for the damage rate when accompanied by co-irradiation annealing is $dn_{(E)}/dt = a_{(E)}\,\phi - Bn_{(E)}\,e^{-E/kT}$. The first term on the right portion of the equation describes the rate of development of damage due to irradiation and assumes the damage to be dilute. The second term describes the rate of annealing and assumes first-order reactions, a most probable assumption for elevated temperature irradiation. Methods for obtaining values of B and E in the annealing function are described, and typical values derived from annealing data are presented. Post-irradiation annealing data on steel show that the B value is $\sim 1 \times 10^{21}$ but may vary in a continuous manner as annealing progresses. The activation energy (E) is not a single value but exists as a spectrum of values ranging for irradiated steel from 2.0 to 3.6 eV. The B values and the activation energy spectra vary depending on the steel and the irradiation environment. It is postulated that the variations in irradiation response of commercial low-alloy steel irradiated at temperatures above 400°F are a result of the variations in the response to co-irradiation annealing and that the response to irradiation damage at elevated temperatures is a function of the degree and character of the deoxidation of the steel. (auth)

22597 STAINLESS STEEL ALLOY EXHIBITING RESISTANCE TO EMBRITTLEMENT BY NEUTRON IRRADIATION. Martin, William R.; Weir, J. R. (to United States Atomic Energy Commission). U. S. Patent 3,440,037. Apr. 22, 1969.

An improved structural alloy material for service in a neutron environment is described. The improvement comprises a boride-forming element incorporated in the alloy in an amount which forms a homogeneous dispersion of boride within the metal matrix of the alloy, reducing the migration of the boron to the grain boundaries. The alloy consists of 17 to 20% chromium, 8 to 11% nickel, a small proportion of carbon, 0.1 to 0.25% titanium, incidental amounts of boron-10, and the balance iron. (AEC)

22598 EFFECT OF FAST NEUTRON IRRADIATION ON THE TEMPERING OF PLAIN-CARBON STEELS. Sastri, A. S. (Iowa State Univ., Ames); Walker, D. G. J. Aust. Inst. Metals, 13: 163-8(Aug. 1968).

Specimens of 2 plain-carbon steels, of 1% and 0.7% carbon, respectively, and in the as-quenched condition, were irradiated at temperatures between 70°C and 100°C to fast neutron doses from 10^{17} nvt to 5×10^{19} nvt (>1 MeV). Measurements were made of the indentation hardness, electrical resistivity, and x-ray-diffraction line broadening on the as-irradiated specimens and after tempering at temperatures to 500°C, and the results were compared with those from unirradiated control specimens. Direct observations of structural changes were also made, using transmission electron microscopy. The results showed that at temperatures less than 300°C tempering was more rapid for the irradiated specimens but at higher temperatures it was independent of prior irradiation. The response to irradiation of the measured properties was not uniform and the recovery of the electrical resistivity was much greater than that of hardness or x-ray line breadth. It is suggested that, during irradiation, carbon atoms become associated with lattice vacancies and are removed from interstitial positions. In addition, at sufficiently high doses, diffusion processes are enhanced so that carbide precipitation is increased. (BBB)

22599 STAGE-I INTERSTITIALS IN ELECTRON-IRRADIATED TUNGSTEN. DiCarlo, J. A.; Snead, C. L. Jr.; Goland, A. N. (Brookhaven National Lab., Upton, N. Y. Phys. Rev., 178: 1059-72(Feb. 15, 1969).

Single crystals and polycrystalline 5-mil tungsten wires of high purity were irradiated at 20°K with 2.5-MeV electrons. Stage-I defect behavior was studied by internal friction, dynamic Young's-modulus, and resistivity measurements. The friction and modulus samples were electrostatically driven at their fundamental flexural mode (~600 Hz). After irradiation, a prominent but transient internal-friction peak was observed at 30°K. Simultaneous resistivity and mechanical-property measurements during isochronal annealing indicates that the friction peak recovers during a major close-pair recovery substage, and that long-range interstitial motion occurs between 45 and 100°K. Arguments are presented which identify the stress-induced ordering of the interstitial members of close Frenkel pairs as the source of the 30°K relaxation peak. Single-crystal results on relaxation strength versus stress direction suggest that the interstitials are not ⟨111⟩ but most probably are ⟨110⟩ split interstitials. Defect asymmetry and activation energies for reorientation ($E_r = 0.066 \pm 0.01$ eV) and annealing ($E_a = 0.11 \pm 0.01$ eV) are determined for the 30°K process. A discussion of internal-friction background increase with heavy irradiation is also presented. (auth)

22600 A PHENOMENOLOGICAL THEORY OF NEUTRON IRRADIATION SENSITIVITY OF DUCTILE–BRITTLE TRANSITION TEMPERATURE OF FERRITIC STEELS. Igata, Naohiro; Hasiguti, Ryukiti (Tokyo Univ.). Trans. Iron Steel Inst. Jap., 8: 386-91(Nov. 1968).

The change of ductile–brittle transition temperature of ferritic steels owing to neutron irradiation was investigated and a phenomenological theory is presented. The theory predicts the change of sensitivity $(\delta(\Delta T_\phi))$, in terms of the changes of grain size, interstitial solute atom concentration, spacing of precipitates, and dislocation density. (auth)(NSA of Japan)

22601 SPATIAL DISTRIBUTION OF IRRADIATION DAMAGE SPOTS. Minter, F. J.; Foreman, A. J. E. (Atomic Energy Research Establishment, Harwell, Eng.). J. Mater. Sci., 4: 218-22 (Mar. 1969).

The fine-scale damage spots observed in thin foils of neutron irradiated copper do not always appear to be entirely randomly distributed, and show in particular some apparent lining up of spots. A digital computer was used to determine the number of linear triplets of spots in both a foil and a series of random arrays, the results being displayed pictorially by an electronic graph plotter. No significant difference between the results for the foil and the random arrays was found. The near-randomness of the spots was confirmed by counts of the density distribution function for two foils, which both showed almost a Poisson distribution. It is concluded that the apparent "structure" in the distribution of the irradiation damage spots is wholly compatible with that of random arrays. This result may have general implications in other branches of metallography. (auth)

22602 EFFECTS OF TEMPERATURE ON DISLOCATION PINNING IN ELECTRON IRRADIATED COPPER. Keefer, D. W. (Atomic International, Canoga Park, Calif.). Contract AT-(04-3)-701. Acta Met. 17: 611-22(May 1969).

The effect of temperature on the number of dislocation pinners produced in copper by electron irradiation was studied. The electron doses were kept low so that very small numbers of point defects were produced. Two irradiation techniques were employed. One involved irradiation at 77, 125, or 150°K. In the other the sample was alternately irradiated at 77°K and annealed at either 125 or 150°K. In both procedures, modulus and internal friction measurements were made at 4.2 and/or 77°K. If the alternate procedure is employed, measurements at 77°K show that the number of pinners is less following an anneal than it was immediately after the 77°K irradiation. On the other hand, measurements at 4.2°K show that a net increase in pinner density occurred during this same anneal. It is suggested that these results are evidence that different portions of the dislocation population are being used at 77 and 4.2°K to monitor the pinner density and that the behavior of point defects on these dislocation groups is different. An enhancement of pinning at 77°K is observed after an anneal or irradiation at 125 to 150°K. These enhancement effects are observed only in samples exhibiting a well-defined relaxation peak at 80°K (frequency ~300 c/s) and can be observed at measuring temperatures between 40 and 150°K. This is the temperature range over which the relaxation peak occurs. These results are discussed in terms of a model in which enhanced pinning occurs because of a distribution of Stage I interstitials on dislocations. Enhancement of modulus Stage III at 200 to 250°K is observed following irradiation at 150°K over that after irradiation at 77°K. This result is discussed in terms of the possible conversion of Stage I to Stage III type interstitials. (auth)

22603 RADIATION HARDENING IN SINGLE CRYSTAL NIOBIUM: THE TEMPERATURE DEPENDENCE OF YIELDING. Wechsler, M. S. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville); Tucker, R. P.; Bode, R. Acta Met., 17: 541-51(May 1969).

Neutron-irradiated single crystals of niobium were tensile tested over a range of temperatures from 93 to 298°K. The yield and flow stresses were increased upon irradiation, and the rate of work hardening, the uniform strain, and the fracture strain were reduced. Slip markings on polished surfaces were coarser and more inhomogeneous for the irradiated samples. The increase in the critical shear stress upon irradiation was approximately the same over the entire range of test temperatures, with perhaps a slight tendency for greater hardening at lower temperatures. The shape of the stress–temperature (τ vs. T) curve was analyzed according to several expressions. A reasonably good fit to the Fleischer expression, $(\tau/\tau_0)^{½} = 1 - (T/T_0)^{½}$, was obtained, but an equally good fit was found to the simpler relation $(\tau/\tau_0) = 1 + (T_0/T)$. It is suggested that radiation-produced obstacles exert long-range stresses, giving rise to an athermal inhibition to dislocation motion. A simple analytical treatment is presented that illustrates conditions under which the radiation-hardening is expected to be athermal. (auth)

22604 DISLOCATION PINNING AND DEPINNING IN ELECTRON IRRADIATED MOLYBDENUM. Lomer, Jenifer N.; Taylor, R. J. (Univ. of Reading, Eng.). Phil. Mag., 19: 437-48(Mar. 1969).

The internal friction of electron irradiated molybdenum was studied between 45 and 330°K. Dislocation pinning occurred between 50 and 70°K and is interpreted as arising from the movement of interstitials to the dislocations. A broad-stage of depinning occurred above 90°K, and the friction recovered to its pre-irradiation value after a few hours anneal at 330°K. The depinning is thought to be due to the release of the interstitial pinning points from dislocations with different binding energies. The correlation of the pinning with the electrical resistivity annealing data, and the difficulties of interpretation, are similar to those found in the f.c.c. metals. The apparent value of the displacement energy measured was about 50 eV. This is much higher than the value of 37 eV found by Lucasson and Walker (1962). It may be that more energy is needed to form a widely separated interstitial vacancy pair than a close pair, and only interstitials from the former move to and pin dislocations. (auth)(UK)

22605 LOW-TEMPERATURE RECOVERY OF ELECTRON-IRRADIATED TUNGSTEN. Roberts, Clyde Gordon. Chapel Hill, N. C., Univ. of North Carolina, 1968. 47p.
Thesis.

Pure (99.9995%) tungsten was used for a study to determine the threshold energy for damage and the temperature at which free lattice migration begins. The threshold energy for damage was found to be 47 ± 3 eV. An annealing peak at 22°K was found that is definitely due to long range migration. It was concluded that the minimum temperature for long range migration must be 22°K or less. (Diss. Abstr.)

22606 RECOVERY OF PURE AND ALLOYED ALUMINUM IN STAGES II AND III AFTER 2 MeV ELECTRON IRRADIATION. Peters, Philip Boardman. Chapel Hill, N. C., Univ. of North Carolina, 1968. 121p.
Thesis.

Pure (99.9999%) and dilutely alloyed samples of aluminum were irradiated at temperatures below the conclusion of Stage I and the recovery in the region 60 to 300°K was studied. Impurities in the samples dominate the recovery through Stage II and into Stage III, with the possibility of an intrinsic process occurring in the vicinity of 75°K in both the pure aluminum and the alloys. The addition of 0.3 atomic percent of Zn, Cu, and Ge is found to influence the recovery in Stage III, as well as Stage II. A model in which single vacancies migrate to clusters of interstitials, which were formed during the preceding stages of recovery, appears to best account for the Stage III recovery of pure aluminum. (Diss. Abstr.)

22607 STAGE II RECOVERY OF ELECTRON RADIATION DAMAGE IN NICKEL. Rickey, Wynn Patterson. Chapel Hill, N. C., Univ. of North Carolina, 1968. 61p.
Thesis.

Samples of 99.995 and 99.98% pure nickel were irradiated with 2 MeV electrons produced by a Van de Graaff generator. The recovery of the radiation-induced resistivity increase was measured as a function of temperature, using an isochronal annealing technique. The temperature range from 60 to 240°K was investigated, and four reproducible substages of recovery activity were found. These substages occur at 80, 100, 160, and 220°K and are designated as II_A, II_B, II_C, and II_D, respectively. Indications of the beginning of another substage, II_E, was found at 240°K. Experiments with different amounts of damage were carried out to determine the dependence upon defect concentration of the recovery spectrum. Recovery spectra of irradiations performed at 38 and 60°K were compared, and the production rates of damage for the two irradiations were also compared. (Diss. Abstr.)

22608 CHARACTERS OF DEFECT CLUSTERS IN IRRADIATED METALS. Norris, D. I. R. (Central Electricity Generating Board, Berkeley, Eng.). Phil. Mag., 19: 527-32(Mar. 1969).

Character determinations for small point defect clusters were made using depth measurements by stereo electron microscopy in conjunction with the observation of the senses of black-white images. In gold, nickel, and aluminum bombarded with 80 to 150 keV heavy ions to doses $\sim 10^{15}$ m^{-2} and in neutron-irradiated gold the clusters were found to be comprised of vacancies, confirming previous conclusions. For ion-bombarded metals character determinations by various workers fit a clear pattern. Vacancy clusters are formed from displacement cascades and may be observed by electron microscopy at doses $\sim 10^{15}$ m^{-2}. If clusters are below the visibility limit, however, then ion doses $\sim 10^{19}$ m^{-2} give interstitial clusters by a diffusion mechanism. For neutron-irradiated metals results depend upon parameters that have not yet been sufficiently explored. (auth)(UK)

22609 GAMMA RADIATION EFFECTS ON ORDERING PROCESSES IN Ni–Fe ALLOYS. Kharlamov, Yu. S. (Moscow Engineering Physics Inst.). Fiz. Metal. Metalloved., 26: 931-3 (Nov. 1968). (In Russian).

Gamma radiation effects on magnetic properties of Ni–Fe alloys with a composition close to the superstructure Ni_3Fe were studied using specimens irradiated by ^{60}Co γ quanta at 580, 600, and 980 r/sec at 20 to 100°C. Kinetic curves constructed for magnetic property variations μ_m and H_c in a specimen with 78.5% Ni–21.5% Fe at 350° and 450°C annealing temperature showed an increased rate of μ_m and H_c variations in specimens irradiated with 1.9×10^{17} γ-quanta/cm^2 at 395°C. Data obtained indicated that γ irradiation effects on the kinetics of ordering processes depend on the structure of the alloy. (R.V.J.)

22610 SWELLING OF AUSTENITIC STAINLESS STEELS UNDER FAST NEUTRON IRRADIATION AT ELEVATED TEMPERATURES. Lauritzen, T. (General Electric Co., Sunnyvale, Calif.); Withop, A.; Wolff, U. E. Nucl. Eng. Design, 9: 265-8(Feb. 1969).

A discussion of studies on volume increase phenomena observed in highly irradiated austenitic stainless steels is given. Volume increases are related to the production of polyhedral cavities. The likely source of swelling is a combination of the effects of two reactions: the helium-producing (n,α) reaction, and the vacancy-producing displacement reaction. It is believed that helium atoms so generated stabilize the cavity nuclei. (auth)

22611 VARIATION OF THE MECHANICAL PROPERTIES OF IRRADIATED HASTELLOY N WITH STRAIN RATE. McCoy, H. E. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 31: 67-85(May 1969).

The postirradiation mechanical properties of several heats of Hastelloy N, both vacuum- and air-melted, have been measured after exposure to thermal fluences of 2 to 6×10^{20} neutrons/cm^2. At strain rates normally encountered in tensile tests, the fracture strain is sensitive to strain rate at 500 to 650°C. At 650°C a minimum fracture strain was observed at a strain rate of approximately 0.1%/hr; the strain increased rapidly with increasing strain rate and increased gradually with decreasing strain rate. Although the fracture strains at high strain rates differed significantly for test temperatures of 650 and 760°C, the strains were the same under creep conditions. A titanium-modified alloy showed improved resistance to irradiation damage. Qualitative explanations are given for each of these observations. (auth)

22612 SWELLING AND HELIUM DAMAGE IN REACTOR MATERIALS. Mishima, Yoshitsugu; Ishino, Shiori (Tokyo

Univ.). Nippon Genshiryoku Gakkaishi, 11: 96-105(Feb. 1969). (In Japanese).

The production of inert gases by irradiation gives rise to various consequential effects on reactor materials such as swelling, fission product release and high temperature embrittlement. A review is presented on the production and the behavior of inert gases in reactor materials. Special emphasis is placed on the behavior of gas bubbles in solids. Studies in this field should be indispensable, for example, in raising the burnup attainable with metallic fuels and in preventing high-temperature embrittlement in FBR fuel cladding materials. The production of gas atoms by irradiation, and gas atoms in the "as irradiated" condition are discussed. The nucleation and growth of gas bubbles are treated, attention is drawn to the importance of the role of vacancies, and the migration of bubbles especially under various generalized forces is discussed. Finally, reference is made to the effects of gas bubbles in three typical cases, i.e., in metallic fuels, in UO_2, and in stainless steels. Methods used to minimize swelling are also discussed. (auth)

22613 THEORY OF THE CREEP OF ZIRCALOY DURING NEUTRON IRRADIATION. Nichols, F. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). J. Nucl. Mater., 30: 249-70 (Apr. 1969).

A comprehensive model is proposed to explain the creep of Zircaloy during neutron irradiation. The in-pile softening observed at low stresses is hypothesized to be due to a combination of the growth-directed Roberts-Cottrell yielding creep originally proposed for α-uranium and the formation of point defect loops preferentially on certain planes in response to the applied stress, with the second process being of relatively greater importance. The in-pile hardening observed at high stresses (or strain-rates) is believed caused by cutting by dislocations of depleted zones as originally proposed by Seeger to account for post-irradiation hardening. In this stress (strain-rate) region, in-pile behavior is identical to post-irradiation behavior. At intermediate stresses (strain-rates) a mechanism of radiation-enhanced climb around depleted zones is suggested as being rate-controlling. As the stress is decreased, the climb process becomes easier and the rate is then controlled by glide at a flow stress characteristic of unirradiated, annealed material, it being proposed that radiation-enhanced diffusion enables climbing around the normal strain-hardening obstacles. At still lower stresses, this glide process becomes negligibly slow compared with the growth-connected creep mechanism which is presumed to operate independently. The overall scheme is shown to be in good agreement with all the in-pile data presently available and arguments are presented for the acceptance or rejection of concepts previously proposed in the literature. (auth)

22614 ANNEALING OF CREEP FRACTURE DAMAGE IN A STAINLESS STEEL. Evans, H. E.; Waddington, J. S. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater., 30: 337-9(Apr. 1969).

Damage annealing in unirradiated and irradiated Cr–Nb–Ni–stainless steel was investigated. An unirradiated specimen was strained to a late stage of secondary creep, unloaded, annealed for 84.6 ksec at the creep temperature, and strained to failure. No measurable recovery of ductility occurred. The strain increment prior to annealing was reduced to 2% and annealed at 84.6 ksec before straining. A small amount of recovery occurred. Repetitive straining at 3.6 ksec and 84.6 ksec was adopted and full recovery of ductility occurred. Using the repetitive technique with annealing periods of 3.6 ksec and 84.6 ksec for irradiated specimens achieved partial recovery at 3.6 ksec and complete recovery at 84.6 ksec. (F.S.)

22615 IRRADIATION-INDUCED SWELLING OF URANIUM CARBIDE. Harrison, J. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Nucl. Mater., 30: 319-23(Apr. 1969).

Homogeneous nucleation theory is applied to uranium carbide to describe bubble formation and swelling. It is concluded that at temperatures $\leq$700°C and for burn-ups less than 5×10^{20} fissions/cm^3, bubble formation is unlikely. A bubble nucleation time is predicted and its temperature-dependence discussed. Comparisons are illustrated between calculated and observed swelling of unrestrained uranium carbide and finally results are presented of calculations of carbide swelling under various idealized conditions. (auth)

22616 FISSION GAS INDUCED SWELLING IN URANIUM AT HIGH TEMPERATURES AND PRESSURES. Kulcinski, G. L.; Leggett, R. D.; Hann, C. R.; Mastel, B. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater., 30: 303-13(Apr. 1969).

The effect of externally applied hydrostatic pressures at 0 to 1000 bar at 900°C on the fission gas induced swelling in uranium has been studied. The swelling is a sensitive function of pressures below 110 bar and relatively insensitive to pressures above 110 bar. Metallography of the samples shows that the average diameter of the bubbles is reduced from 3300 to 1800 Å and the total number increased from 0.9 to 4.2×10^{12}/cm^3 as the annealing pressure is increased from 0 to 110 bar respectively. Further increases in pressure from 110 to 1000 bar have little effect on the average bubble size and density. The mechanism of pressure reduced swelling is discussed in terms of the equilibrium number of vacancies that can be associated with fission gas atoms under stress. It is also shown, both experimentally and theoretically, that there is a loss of surface area when bubbles coalesce under pressure. (auth)

22617 RADIATION DAMAGE IN VANADIUM. Rau, R. C.; Ladd, R. L. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Nucl. Mater., 30: 297-302(Apr. 1969).

Transmission electron microscopy has been used to study the microstructure of neutron irradiated single crystal vanadium. These observations revealed the presence of small defect clusters which, upon annealing, grew into resolvable dislocation loops, analyzed as interstitial in nature. The radiation-induced clusters and loops were stabilized during annealing by interaction with impurity precipitates. Damage shells, ascribed to transmutation reactions, were found surrounding certain particles believed to contain boron. (auth)

22618 EFFECT OF HYDROGEN AND NEUTRON IRRADIATION ON THE FAILURE OF FLAWED ZIRCALOY-2 PRESSURE TUBES. Cowan, A.; Langford, W. J. (United Kingdom Atomic Energy Authority, Culcheth, Eng. Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 30: 271-81 (Apr. 1969).

Experiments were made with Zircaloy-2 tubes containing axial slits. Failure stress at 20 and 300°C is increased by neutron irradiation: hydride precipitates reduce failure stress at 20 but not at 300°C. There is evidence that stress applied during irradiation, and neutron dose affect failure stress. Crack opening displacement measurements on notched bend specimens predicted within 20% the critical crack lengths measured on full size tubes. (auth)

Ceramics and Cermets

Refer also to abstract 22455.

22619 (AAEC/TM-487) A REVIEW OF THE PHYSICAL, MECHANICAL, AND IRRADIATION PROPERTIES OF U_3Si AND U_3Si_2. Bardsley, J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1968. 41p. Dep.

U_3Si has potential for use in heavy water moderated water cooled nuclear reactors. A review of the literature prior to June 1967 on the production and properties of U_3Si and U_3Si_2 (which is often present in alloys of nominal U_3Si composition) is presented. Comments on critical aspects of U_3Si in relation to the requirements of power reactors are included. (auth)

22620 (WAPD-3791-28) OXIDE FUEL ELEMENT DEVELOPMENT. Quarterly Progress Report for the Period Ending September 30, 1968. Bleiberg, M. L.; Biancheria, A.; Ray, W. E.; Riley, B. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Oct. 1968. Contract AT(30-1)-3791. 80p. Dep. CFSTI.

Analyses of all available cladding swelling data have been performed and the data examined for the influence of cold working and carbon content on swelling. The effect of fluence on swelling at 450 and 550°C was established as $\Delta V/V = 0.191\ (\phi t)^{1.143}$ and confidence levels were rigorously calculated for this expression. The effect of nitrogen on post-irradiation cladding ductility was identified. A statistical analysis of United States (US) and United Kingdom (UK) creep data for unirradiated, solution annealed Type 316 stainless steel was performed. It was shown that both the US and UK creep data at 1200°F can be considered to be from the same population. A fuel-swelling model based upon the Eyre and Bullough model was devised for both oxide and carbide fuel. A study of fuel column spacer concepts has been initiated. Design analyses on a grid-type, 37-pin, EBR-II subassembly have begun. Calculations to date show that a 1.20 pitch-to-diameter (P/D) ratio will result in acceptable average power ratings in EBR-II. A survey has been made of potential grids and wrapper materials, and a tentative selection of Inconel 718 has been made as the reference material with Inconel X-750 as the back-up selection. Effect of brazing cycle studies on Inconel 718 and methods of sodium corrosion testing of brazing alloys have begun. Exploratory fabrication development of an electron beam welding of fixed spacers in the cladding was initiated. Thermodynamic calculations have been completed and reference sintering practices were established. A reference fabrication process has been devised based upon the new oxide fuel facility currently being constructed. Also, a complete fuel description and characterization procedure has been established. (auth)

22621 SPECIAL CERAMICS 4. Proceedings of the Fourth Symposium on Special Ceramics held at Queens Road, Penkhull, Stoke-on-Trent on July 11, 12, and 13, 1967. Popper, P. (ed.). Stoke-on-Trent, Eng., British Ceramic Research Association, 1968. 328p. 90s. (CONF-670731).

The 26 papers presented are either reproduced in full or in abstract form. Discussions are included. Ten papers are considered within the scope of NSA and a separate abstract was prepared for each of these. (UK)

For abstracts of individual papers see: 21868, 22634, 22636–22640, and 22663–22665.

Corrosion and Erosion

Refer also to abstract 21858.

22622 EROSION OF THE REFRACTORY ZIRCONIUM OXIDE CERAMICS. 4. SOME OF PECULIARITIES OF GAS EROSION. Abraitis, R. I.; Mayauskas, I. S. (Inst. of Physical and Technical Problems of Energetics, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B, No. 3, 103-8(1968). (In Russian).

Erosion tests have shown that in high temperature gas streams with the wall temperature up to 2600°K, not only vaporous products but also separate grains of other substances are removed from the wall as well as occurring crystal growth on the eroding surface exposed to the action of the stream. The erosion products have been collected in a series of groups as to their geometrical patterns and chemical composition. Analysis of the erosion products makes it possible to foresee their destructive effect on the erosion durability of construction elements and units beyond the experimental area in the direction of the flow. (auth)

22623 OXIDATION KINETICS OF TANTALUM CARBIDE. Gibby, Ronald L.; Wadsworth, Milton E. (Univ. of Utah, Salt Lake City). Met. Soc. Conf., 34: Pt. 1, 305-24(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

Sized powdered samples of TaC were oxidized at various partial pressures of oxygen from 1.3×10^{-2} to 0.86 atmospheres at 640 to 825°C and in pure oxygen at 600 to 630°C. Above 670°C the reaction was observed to be surface controlled resulting in non-protective products, while below 650°C oxidation followed a parabolic rate law. At 650°C and 670°C initial oxidation obeyed neither a linear nor parabolic rate law, but after a brief period linear oxidation occurred. Oxidation has been explained in terms of two parallel linear rate-controlling reactions preceded by an oxygen adsorption process. The parallel surface reactions with activation enthalpies of 108 and 55 kcal per mole are believed to be rate-controlling during linear oxidation, while a diffusion process with an activation enthalpy of 55 kcal per mole is believed to be rate-controlling below 650°C. A model is presented for linear oxidation in which steady state diffusion across an intermediate product of constant thickness occurs. (auth)

22624 OXIDATION BEHAVIOR OF URANIUM MONOSULFIDE. Nakai, Eiichiro; Kanno, Masayoshi; Mukaibo, Takashi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 6: 138-42(Mar. 1969).

The oxidation behavior of uranium monosulfide powder in oxygen and air has been studied over a range from room temperature to 900°C, by means of differential thermal analyses, thermogravimetric analyses, x-ray diffraction, and chemical analysis. Most of the reactions occurring during the oxidation process have been identified. Intermediate oxidation products observed are γ–US_2, UOS, UO_2SO_4, UO_2, and UO_{2+x}. (auth)

22625 WEAR PROPERTIES OF TUNGSTEN CARBIDE AND ALUMINIUM OXIDE SINTERED MATERIALS. Dawihl, W.; Frisch, B. Wear, 12: 17(1968).

These properties were determined by loading and temperature-dependent welding phenomena. At high temperatures a healing process occurs which increases the mechanical resistance of both types of material and reduces their wear accordingly. It is assumed that healing processes lead to the relief of internal stresses of the second kind. The wear of aluminum oxide is also affected by mechano-chemical processes. In the presence of organic acids used as surface-active media, salts of Al_2O_3 are formed. (Brit. Ceram. Abstr.)

22626 FUNDAMENTALS OF TOOL WEAR. Ham, Inyong. Technical Paper No. MR68-617. Dearborn, Mich., American Society of Tool and Manufacturing Engineers, 1968. 23p.

Tool wear criteria are developed in terms of expressions for flank and crater wear. Flank wear may be of six different types: uniform wear, nose wear, maximum groove on the side-flank, nose wear and side groove wear combined, groove wear on the end-flank and chipping wear. A combination of flank and crater wear produces several patterns, including chipping on both face and flank, breakdown of the cutting edge and plastic deformation of the cutting edge. Mechanisms for wear by abrasion, chipping and fracture, adhesion, oxidation, or diffusion are postulated. Results of wear studies by the electron microprobe analysis and activation analysis methods applied to chips and by simulation tests of frictional interface reaction are given. Graphs and charts show wear of single-point tools during turning, typical wear patterns of WC, TiC, and Al_2O_3 tools in finish machining, typical flank and crater wear vs cutting time in machining XC45 steel with carbide tools, flank wear rates for a new carbide tool and three cemented carbide tools machining gray cast iron. (Metals Abstr.)

Preparation and Fabrication

Refer also to abstracts 22505, 22667, and 24035.

22627 (BM-RI-7247) PREPARATION OF TUNGSTEN CARBIDE BY ELECTRODEPOSITION. Gomes, John M.; Wong, M. M. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). Apr. 1969. 13p.

The preparation of tungsten carbide by molten-salt electrolysis was investigated. Sodium tungstate in the electrolyte and carbon from the graphite anode were the source materials. Optimum results were obtained with an electrolyte consisting of 83 mole % sodium chloride and 5.7 mole % each of sodium tungstate, sodium metaborate, and sodium hydroxide; a temperature of 1,000 to 1,025°C; an anode current density of 37 A/dm^2 or less; and an initial cathode current density of 150 A/dm^2. The yield was approximately 0.45 g/Ah. The electrolytic tungsten carbide product contained approximately 5.4 wt. % combined carbon as compared to 6.1 wt. % for pure tungsten carbide. Microhardness of the electrolytic tungsten carbide, determined with a 50-gram load, varied from 3,480 to 3,970 dph. The material was friable and could be ground in a laboratory ball mill to less than 400-mesh particle size. (auth)

22628 (LIB-Trans-190) INDUSTRIAL SINTERING OF URANIUM OXIDE IN A CONTINUOUS FURNACE. Hauser, R.; Porneuf, A. Translated by Jack Kristo from pp 137-54 of New Nuclear Materials Including Non-Metallic Fuels, Vienna, July 1-5, 1963. 17p. Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 17: 32550. (TSS)

22629 STUDY OF THE PROJECTION OF BORIDES AND NITRIDES BY THE PLASMA GUN. Bentz, G.; Provost, G.; Urban, C. Bull. Soc. Fr. Ceram., No. 78, 5-17(Jan.-Mar. 1968). (In French).

The study of a plasma to deposit refractory nitrides and borides is described. A number of compounds were investigated including TiB_2, TaB_2, NbB_2, ZrB_2, TiN, ZrN, TaN, and several others, in less detail. The apparatus used for projection by a plasma jet is described and illustrated. Argon, N_2, and mixtures of these with H_2 were used. A physical chemical study of deposits produced by plasma deposition of the refractory compounds includes reports of mechanical resistance to bending, modulus of elasticity, thermal conductivity, thermal dilatation, electric resistivity, chemical composition, microstrength, crystallographic composition, and resistance to oxidation. Development of the projection technique was directed to production of stress-free coatings, determination of proper mixtures of gases for the plasma, and optimization of energy consumption and weight of material sprayed. (BBB)

22630 DEPOSITION OF ZIRCONIUM CARBIDE BY VAPOR PHASE REACTION. Takahashi, Takehiko; Sugiyama, Kozo (Nagoya Univ., Japan). Kinzoku Hyomen Gijutsu, 19: 514-19 (Dec. 1968). (In Japanese).

The optimum temperature and relating factors for vapor deposition rates of zirconium carbide were measured using a thermo-balance. Deposition was observed at temperatures above 770°C and the (100) planes were developed in parallel with the surface of graphite substrate. The (110) and (100) planes were found to be relatively distinct at above 840 and 1200°C, respectively. The deposition took place within 0.4 sec after the two reacting gas streams were mixed. The deposition rates were proportional to the linear velocity of hydrogen and the concentrations of zirconium tetrachloride and hydrocarbons. The increase of the rates with temperature was less marked at higher temperatures owing to the pyrolysis of hydrocarbons. The highest were found when 0.3 ~ 0.7 vol % paraffins and naphthenes were used. The performance of benzene was not comparable to paraffins and naphthenes because of its anti-pyrolytic property; its growth rate being 0.3 ~ 0.8 μ/min at 1200 ~ 1300°C. (auth) (NSA of Japan)

22631 GRAPHITE FORMATION FROM LOW TEMPERATURE PYROLYSIS OF METHANE OVER SOME TRANSITION METAL SURFACES. Robertson, S. D. (Univ. of Glasgow). Nature (London), 221: 1044-6(Mar. 15, 1969).

Some studies are described on synthetic graphite formation by the thermal decomposition of methane over iron, cobalt, and nickel surfaces. These metals were in the form of thin foils maintained at 650 or 750°C in methane at a pressure of 60 cm Hg. The flaky carbon deposit, with crystallite area, from methane pyrolysis over nickel at 750°C, is shown; also Moiré patterns from carbon formed on cobalt at 750°C, selected area diffraction patterns from carbon deposited on iron at 750°C, and comparative electron diffraction patterns for purified natural graphite and carbon deposited on iron at 750°C. With a view to understanding how the observed unusual structural properties arose, especially at low pyrolysis temperatures, various aspects of the interaction of methane with iron, cobalt, and nickel surfaces were examined by X-ray powder and electron microprobe analysis, scanning microscopy, and gas analysis. Surface studies of the deposited graphites were also carried out. (UK)

22632 ION EXCHANGE METHOD FOR PREPARING METAL OXIDE MICROSPHERES. Lonadier, Frank D.; Brown, Willard B.; Fushimi, Fred C.; Silver, Gary L. (to United States Atomic Energy Commission). U. S. Patent 3,438,749. Apr. 15, 1969.

A method is described for the preparation of small plutonium oxide spheres by employing ion exchange resins. A bonded resin is removed from plutonium oxide by igniting in a furnace. (AEC)

22633 FLUIDIZED-BED CHLORINATION OF ZIRCONIUM-BEARING MATERIALS. Spink, D. R. (Carborundum Metals Co., Akron, N. Y.); Cookston, J. W.; Hanway, J. E. Jr. Met. Soc. Conf., 34: Pt. 1, 375-84(1968).

From Conference on High Refractory Metals, New York. See CONF-650227-(Pt.1).

Second stage fluidized bed chlorination of zirconium carbides and oxides to tetrachlorides was evaluated for preparation of feed materials to be used in the production of high purity zirconium. Results indicate that there is no critical impediments to the fluidized-bed chlorination of either oxide or carbide zirconium materials. The chlorination of zirconium carbide can be conducted autogenously in a conventional fluidized-bed system at 500 to 600°C. The rate of dissipation of excess thermal energy appears to be the critical factor during such chlorination and the fluidized bed is well suited for high rates of heat dissipation. The chlorination of zirconium oxide, fused zirconium oxide, or zircon ore can be carried on in a resistively heated fluidized bed of carbon particles at 1000 to 1200°C with good conversions and chlorine utilizations. (auth)

22634 COATING OF URANIUM MONOCARBIDE WITH SILICON CARBIDE IN A FLUIDIZED BED. Ford, L. H.; Hibbert, N. S.; Ingleby, B. E.; Walker, D. E. Y. (United Kingdom Atomic Energy Authority, Springfields, Eng.). pp 121-38 of Special Ceramics 4. Popper, P. (ed.). Stoke-on-Trent, Eng., British Ceramic Research Association, 1968.

From 4th Symposium on Special Ceramics, Stoke-on-Trent, England. See CONF-670731.

Pyrolytic silicon carbide has been applied to uranium monocarbide kernels in a 1.5-in.-dia fluidized bed from methyltrichlorosilane in the presence of hydrogen or hydrogen/argon mixtures at 1200-1700°C. At a deposition temperature of 1200°C the silicon carbide coatings contain free silicon and carbon, whereas in the temperature range 1500-1650°C the coatings are essentially β-SiC. In this temperature range variations of deposition rate influence the density, texture and α-SiC content of the coating. At deposition rates below 200 g/hr, dense β-SiC is deposited with a coarse granular texture, but smooth outer surface. At deposition rates above 200 g/hr, the coats were porous and contained α-SiC. Partial replacement of the hydrogen fluidizing gas with argon led to α-SiC and porosity in the coating. Increasing the deposition temperature still further to 1700°C caused reaction between the UC and SiC. In general, coatings were bonded to the uranium monocarbide kernels, and because of the disparity in thermal expansions the strengths of the kernel and coating had to be optimized to prevent cracking of the coating on cooling from the deposition temperature and on reheating during later fuel manufacturing processes. (auth) (UK)

22635 IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF GRAPHITE. Redding, Geoffrey Brian; Graham, Leslie Wilfred; Price, Michael Stuart Thomas (to United Kingdom Atomic Energy Authority). British Patent 1,147,456. Apr. 2, 1969. Filed Aug. 9, 1965.

The object of the process described is to produce graphitic material which is substantially isotropic, at least with regard to thermal expansion, starting with anisotropic material. The graphitic granules are tumbled in such a manner that larger particles are formed by snowballing the granules with anisotropic grains smaller in size than the granules, and forming the enlarged particles into a coherent body. A binder is preferably employed in the tumbling operation, and the forming process is preferably followed by a heat treatment. It is preferable to employ powdered grains which have been pre-treated with a binder, and to contact these grains with a binder solvent prior to entry into the tumbling apparatus. Examples of application of the process are given. It was found that the product isotropy was not appreciably impaired by subsequent forming operations. (UK)

22636 PREPARATION OF CRYSTALLINE REFRACTORY CARBIDES AND BORIDES BY ZONE MELTING. Brookes, C. A. (Univ. of Bradford, Eng.); Packer, M. E. pp 15-28 of Special Ceramics 4. Popper, P. (ed.). Stoke-on-Trent, Eng., British Ceramic Research Association, 1968.

From 4th Symposium on Special Ceramics, Stoke-on-Trent, England. See CONF-670731.

The carbides and borides of the transition metals of groups IV, V, and VI of the periodic table are characterized by extremely high melting points. Several of these materials have been melted using radio-frequency heating and a cold crucible. Because of partial levitation in the r.f. field, materials with melting points up to 3500°C can be melted and crystallized, without contamination, in a horizontal water-cooled boat. The behavior of these materials (including UC) during melting and crystallization is described and the composition and structure of the products are discussed. Preferential loss of one of the components usually occurs from and near the molten zone. In some cases this leads to the formation of secondary phases. Many of the compounds can, however, exist over a wide range of composition, and fully dense single-phase specimens with grain size up to 0.5 cm have been prepared. (auth) (UK)

22637 NEW CERAMIC MATERIALS FROM THERMAL AND HYDROLYTIC DECOMPOSITION OF METAL ALCOHOLATES. Lynch, C. T. (Air Force Materials Lab., Wright-Patterson AFB, Ohio); Mazdiyasni, K. S.; Smith, J. S.. pp 83-4 of Special Ceramics 4. Popper, P. (ed.). Stoke-on-Trent, Eng., British Ceramic Research Association, 1968.

From 4th Symposium on Special Ceramics, Stoke-on-Trent, England. See CONF-670731.

Alcoholates of transition and rare earth metals can be decomposed quantitatively to form high purity (>99.95%) submicron (<500 Å) refractory oxides which exhibit high surface activity in the solid state. This provides a route for the preparation of complex oxides by simultaneous double decomposition of mixed alcoholates. Such mixed phases can be consolidated to homogeneous high-density bodies at low firing temperatures. Yttria-stabilized zirconia was prepared from the decomposition of yttrium isopropoxide and zirconium tetra-tertiary butoxide by aqueous hydrolysis of a non-aqueous solution of the alkoxides. Hafnium titanate was produced in a similar manner from titanium isopropoxide and hafnium tetra-tertiary butoxide. Vapor decomposition of nickel carbonyl and zirconium tetratertiary butoxide produced a homogeneous dispersion of the oxide phase in nickel on sintering. A 6^{m}_{o} yttria-stabilized zirconia powder was fully stabilized in the cubic phase at the low firing temperature of 800°C for 30 min. Theoretically dense, fine grained (1-2 μm) bodies called "Zyttrite" were obtained after cold pressing and sintering at 1450°C for 16 h. The ultimate tensile strength of "Zyttrite" at room temperature was 24,000 lbf/in^2 and Young's modulus 23.5 × 10^6 lbf/in^2. At 2200°C the sample failed at 3200 lbf/in^2 after some plastic deformation had taken place. The modulus of rupture with four-point loading was 14,700 lbf/in^2 at 1050°C. The critical strain up to this temperature was 0.001. The compressive strength was 144,500 lbf/in^2 at room temperature. Hot pressing at 1400°C for 15 min achieved the same result. The refractory body was stable in oxidizing atmospheres to 2200°C and exhibited no deterioration on thermal cycling. Thin sections were translucent, indicative of a low-porosity, fine-grained, refractory oxide. The results suggest broad applicability of the alkoxy-based preparation of single and mixed phase oxides. (auth) (UK)

22638 CERAMIC OXIDES OF CONTROLLED COMPOSITION, SHAPE, AND PROPERTIES FROM SOLS. Hardy, C. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 85-7 of

Special Ceramics 4. Popper, P. (ed.). Stoke-on-Trent, Eng., British Ceramic Research Association, 1968.

From 4th Symposium on Special Ceramics, Stoke-on-Trent, England. See CONF-670731.

Concentrated sols, or dispersions of colloidal particles, of the hydrated oxides or hydroxides of a variety of metals, e.g., Al, Fe, rare-earths, Ti, Zr, Th, U can be prepared. These have advantages for meeting certain requirements in the composition, shape and properties of ceramic oxides. Mixtures with a high degree of homogeneity, such as are required in stabilized zirconia, ferrites and pigments, can be made by mixing sols, or sols and solutions, thereby avoiding dusty or less-efficient processes involved in alternative routes. Oxides required as free-flowing powders can be produced as spheres by several processes by which the sols are gelled before being dried and calcined. The spheres can be produced to fairly closely defined diameters without the production of fines, which usually accompany grinding processes. Other properties or features in which there are differences from oxides produced by conventional routes are higher strength, smaller grain size, controlled porosity, lower impurity pick-up, and lower calcination temperature. (auth) (UK)

22639 PRODUCTION AND PROPERTIES OF PYROLYTIC GRAPHITE. Bailey, P. A. (Morganite Research and Development Ltd., London); Eastman, C. pp 89-101 of Special Ceramics 4. Popper, P. (ed.). Stoke-on-Trent, Eng., British Ceramic Research Association, 1968.

From 4th Symposium on Special Ceramics, Stoke-on-Trent, England. See CONF-670731.

The stripping of hydrogen from the source gas and the subsequent combination of carbon-rich molecules is very rapid at the high temperatures employed in pyrolytic-graphite deposition. If the pressure is too high or the gas flow too slow the carbon molecules tend to form soot in the gas space before they reach the substrate and they deposit a lower density, isotropic carbon. In the experiments described, however, the gas is passed into the furnace through a narrow-bore water-cooled injector and expands from a pressure near atmospheric to a few torr. This gives it a high linear velocity, which ensures that it reaches the substrate quickly enough to prevent sooting. By using this technique at pressures of 10 torr, good deposits of pyrolytic graphite were obtained at over 0.040 in./h. Pyrolytic graphite deposited on 7-μm-dia. graphite fibers has cracked, on cooling to room temperature, into a series of concentric tubes of constant thickness: radius ratio. This ratio, 0.2, is higher than that considered the practical maximum at larger diameters. (auth) (UK)

22640 FABRICATION AND PROPERTIES OF LARGE-DIAMETER TUBES AND COATINGS IN PYROLYTIC SILICON CARBIDE. Lloyd, D. E. (British Ceramic Research Association, Stoke-on-Trent, Eng.); Howard, V. C. pp 103-19 of Special Ceramics 4. Popper, P. (ed.). Stoke-on-Trent, Eng., British Ceramic Research Association, 1968.

From 4th Symposium on Special Ceramics, Stoke-on-Trent, England. See CONF-670731.

In order to develop the potential use of high-strength pyrolytic silicon carbide for high-temperature gas-cooled reactor systems a program was undertaken to produce 5-in.-dia. tubes by pyrolysis of methyl trichlorosilane in the presence of excess hydrogen. Depositing on inductively heated isotropic-graphite substrates at a realistic rate of about 0.015 in./hr, tubes of good surface appearance and uniform thickness were produced using substrate rotation. Small areas of carbon-rich material could not be eliminated without using a high hydrogen: silane ratio and drastically reducing the build-up rate. On removing the substrate many tubes cracked, indicating high stresses in the coatings. The strengths of rings and of specimens cut from rings were much lower than predicted and this is attributed to the presence of microcracks in the material. The effect of fast neutron irradiation on small specimens of pyrolytic silicon carbide is discussed. (auth) (UK)

22641 TERNARY COMPOUNDS OF URANIUM–CARBON AND THE GROUP VIIIA ELEMENTS. Haines, H. R.; Potter, P. E. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 221: 1238-9(Mar. 29, 1969).

The preparation and properties of U_2RuC_2, U_2OsC_2, and U_2PtC_2 are described, and some further details are given on the previously known U_2IrC_2 and U_2RhC_2. The compounds were prepared by arc melting the elements together under argon, employing a carbon electrode. The alloys so obtained invariably showed a complex structure, consisting of U carbides, U-metal binary alloy phases, and the ternary compound. When annealed at up to 1,500°C in vacuo for more than 100 hr the alloys became single phase, suggesting that the ternary compounds are formed peritectically. Details of these compounds are tabulated, including peritectic reaction temperatures, structure, cell size, etc. No ternary compound of this type was found in the U–Pd–C system. It is pointed out that since the second row elements of Group VIIIA are fission products, a knowledge of the phase relationships is of importance in the interpretation of irradiation experiments on carbide fuel materials. (UK)

22642 TECHNIQUE AND APPARATUS FOR MAKING SPHERICAL PARTICLES. Nyboe, S. A. (to AB Atomenergi). Swedish Patent 219,358. Mar. 12, 1968. Priority date Mar. 5, 1965, Great Britain. (In Swedish).

A method is described for making spherical particles of a nuclear fuel for fabrication of reactor fuel elements. A crumbly paste of the nuclear fuel, e.g., uranium dioxide and furfuryl alcohol is put on the inside of a rotating drum. The drum has a curved envelope surface and is mounted on a horizontal axis. (Sweden)

22643 PRODUCTION OF DENSE BODIES FROM CARBIDES, BORIDES, NITRIDES, SILICIDES, OXIDES, AND CERMETS BY PRESSURE SINTERING. Janes, S.; Nixdorf, J. (Battelle-Institutes eV, Frankfurt am Main). Ber. Deut. Keram. Ges., 46: 60-4(Feb. 1969). (In German).

High-melting materials, such as carbides, borides, nitrides, and silicides (hard materials) as well as oxides and cermets, cannot be compacted to dense pore-free bodies by cold pressing and ordinary sintering. By pressure sintering, it was possible to produce bodies with >95% theoretical density. After comparison of the two methods of compaction, the density of the body was given as a function of pressure, sintering temperature and time of sintering. The mechanical strength of pressure-sintered bodies depended on porosity. Since articles of complicated shapes can be produced by pressure sintering, the method is superior to ordinary sintering even just from the point of view of shaping. (auth)

22644 STUDY OF THE MECHANISM OF THE FRITTING REACTION UNDER PRESSURE. Dogu, A.; Petitjean, G.; Accary, A. (CEN de Saclay, Gif-sur-Yvette, France). J. Nucl. Mater., 30: 282-8(Apr. 1969). (In French).

An analysis of the shrinkage curves during hot pressing of U_3P_4-U, UP_2-U, U_3P_4-U-C and US_2-U mixtures, shows that the reaction hot pressing can substantially decrease the densification temperature of refractory compounds provided they could be produced by a solid state reaction without any Kirkendall effect during the pressing of a mixture of a phase plastic at low temperature and another phase unable to react with it before a complete densification of the former. A total densification can be obtained at the hot pressing temperature of the plastic phase. The ratio of its volume to the void volume of the other constituent of the powder mixture must then be greater than 1, possibly of the order of 1.5. (auth)

Properties Evaluations

Refer also to abstracts 21691, 21885, 21892, 22533, 22639, 22640, 22643, 22697, 23946, and 24030.

22645 (AI-AEC-12744, pp 117-22) MIXED CARBIDE FUELS (BASIC PROPERTIES). Ervin, G. Jr. (Atomics International, Canoga Park, Calif.).

The problem of cladding carburization in mixed (U,Pu)C fuel is surveyed. Estimates of allowable ranges in carbon content of (U,Pu)C fuel are given for 5% additions of Cr, Mo, Nb, Re, Ti, V, and W. Analysis of data on phase diagrams and thermodynamic properties indicate that a significant broadening of the allowable carbon range may be achieved by addition of the metals. (J.C.W.)

22646 (AI-AEC-12744, pp 129-30) MIXED CARBIDE FUELS (CASTING STUDIES). Carroll, J. W. (Atomics International, Canoga Park, Calif.).

22647 (ANL-Trans-729) ENTROPY AND HEAT CAPACITY OF URANIUM BORIDES. Podobeda, L. G.; Malykh, V. A.; Frolov, A. V. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from pp 745-65 of Symposium on Thermodynamics of Nuclear Materials with Emphasis on Solution Systems, Vienna, September 4-8, 1967. 27p. (CONF-670915-9). Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 31481. (TSS)

22648 (ANL-Trans-735) STRUCTURE AND PROPERTIES OF CERMETS. Petzow, Guenter; Claussen, Nils; Exner, Hans-Eckart. Translated for Argonne National Lab., Ill., from Z. Metallk., 59: 170-9(1968). 28p. Dep. CFSTI.

Cermets can be treated as a special group of composite materials. An exact definition and classification, however, is rather difficult due to the wide range of developments. Their structure is ruled by geometry and distribution of the different phases as well as by their constitution with broad miscibility gaps. The properties influenced by these factors are discussed in terms of theoretical and empirical relations across the entire concentration range. Bonding between ceramic and metallic phase seriously affects the property dependence on concentration. Relation for strength, Young's modulus, thermal expansion as well as electrical and thermal conductivity are discussed in detail. (auth)

22649 (BARC–344) THERMALLY ACTIVATED DEFORMATION IN DILUTE ZIRCONIUM–OXYGEN ALLOYS. Das Gupta, P.; Arunachalam, V. S. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 29p. Dep.

The effects of temperature and strain-rate on the yield and flow stress of zirconium containing oxygen in the range from 0.09 to about 2.5 at. % were examined at 77 to 700°K. These measurements were coupled with strain-rate change tests and stress relaxation experiments so that all the deformation parameters associated with thermal activation could be evaluated. Results of these measurements showed that the thermal component of flow stress increased with increasing oxygen content of the alloy. Two stages of activation were found to occur for all these alloys. The first stage was associated with the unpinning of dislocation loops from impurity pinning points. At higher temperatures, because of the unpinning of many impurity pinning points, a second stage of activation associated with a different mechanism was found to occur. The variation of certain parameters associated with this stage of deformation strongly suggests the P-N force as the controlling criterion. (auth)

22650 (CEA-CONF-1048) OXIDATION OF URANIUM–CARBON ALLOYS. Moreau, C.; Philippot, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1967]. 23p. (In French). (MET–2/68; CONF-680833–1). Dep.

From 6th International Symposium for the Reactivity of Solids, Schenectady, N. Y.

A systematic study was made of the behavior of U–C alloys in the oxidizing atmospheres of oxygen, water vapor, and pure carbon dioxide. The results showed that the evolution of the texture of the product formed in all three cases by the elevation of the temperature provokes the passage from the linear regime to the parabolic regime. In the case of oxygen and carbon dioxide these linear regimes are probably pseudolinear with ionic diffusional processes in a layer which, because of the formation of gaseous products, can be compact only on a very slight thickness. The limiting step of the mechanisms of these three reactions should be the same: the diffusion of interstitial anions O^{2-} in UO_2 more or less stoichiometrically; the role played by the pressure tends to verify this hypothesis. The stoichiometry of the oxide UO_2 depends on the nature of the gas released, the quantity of carbon it contains, and the compactness. It affects the values of the activation energy measured: the highest (55 kcal/mol) was found in the case of the most reducing medium ($UC + H_2O$), where the oxide was the closest to stoichiometry. The reaction $UC + O_2$ leads to the lowest value (22.5 kcal/mol) and the reaction $UC + CO_2$ had an intermediate value (42.5 kcal/mol). The actual reactivity of the uranium carbide with respect to the carbon dioxide is low: at 700°C for example under normal pressure it is 85 times less than with oxygen. (tr-auth)

22651 (COO-1198-619) THE THERMOELECTRIC POWER OF Au-Ni THIN FILM THERMOCOUPLES. Thornburg, David Devoe (Illinois Univ., Urbana). Oct. 1968. Contract AT(11-1)-1198. 57p. Dep. CFSTI.

A study was made of the reproducibility, stability, and thickness dependence of the thermal emf of Au/Ni thin-film thermocouples. Annealing and outgassing were found to be essential for reducing scatter in the data, and Corning 7059 glass was used as the substrate in conjunction with a special specimen preparation procedure. The Au thickness was well in the region of bulk behavior (1400 and 2700 Å), and the Seebeck coefficients (ΔS) were studied as a function of Ni thickness (200 to 3000 Å). The thickness dependence of ΔS was found to be very slight, with the ΔS values falling in the region of the wire value ($\sim 22\ \mu V/°C$). The results are compared with Mayer's theory of size effect, and possible causes of the remaining data scatter are discussed. Preliminary measurements of response time (200 nsec to 5 μsec) were also made. (D.L.C.)

22652 (GEAP–5720) A THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 5. Aitken, E. A.; Evans, S. K. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Dec. 1968. Contract AT(04-3)-189. 7p. Dep. CFSTI.

Work progress is reported on measurement of liquidus-solidus transformations, vaporization of urania, and oxygen redistribution in a temperature gradient. Several thermal diffusion mechanisms are derived for oxygen redistribution in fast reactor fuel. (auth)

22653 (ORNL–4391) ANISOTROPIC ELASTIC–PLASTIC STRESS ANALYSIS OF A THICK-WALLED GRAPHITE CYLINDER. Moore, S. E. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 119p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

An anisotropic theory of plasticity, for orthotropic metals behavior was modified and used in conjunction with the linear theory of elasticity for the stress and strain analysis of a thick-walled graphite cylinder loaded with an internal pressure. The problem was formulated in terms of the elastic and plastic parts of the small deformation strain components. The solution to the problem—given in terms of the plastic strain increments and the increment of the load ΔP—was evaluated numerically on a digital computer using a predictor-corrector method of successive approximation. An algorithm based on the concept of an effective-stress effective-total-strain relationship was developed for this purpose. The numerical results are presented in graphical form. Results of the analysis were compared with the inside surface and outside surface circumferential strains measured experimentally on a series of 30 thick-walled tube specimens of AGOT reactor-grade graphite which were monotonically loaded with internal pressure until failure occurred. Excellent agreement between the modified theory and experimental mean values was found for the inside surface strains. Less accurate results were calculated for the outside surface strains, indicating a need for further development in the constitutive relations for graphite. The maximum computed stresses were, however, considered acceptable for design purposes. (auth)

22654 (SC-RR–69-160) HIGH-TEMPERATURE PERMEATION OF ZIRCONIA MICROSPHERES BY NITROGEN AND OXYGEN. Meyer, R. T.; Levine, H. S. (Sandia Labs., Albuquerque, N. Mex.). Mar. 1969. 30p. Dep. CFSTI.

A solid state diffusion model was formulated to examine the permeation of gases through zirconia microspheres formed during the short duration (~200 msec), high temperature (3000 to 4000°K) reaction of zirconium with controlled mixtures of nitrogen and oxygen ($N_2/O_2 = 0.025$, 625 torr). The model assumes: the existence of equilibrium-composition zirconium dioxide at 3000°K; oxide-gas interface equilibria; diffusion by motion of lattice vacancies; and nitrogen and oxygen equivalence in oxide permeation. Numerical solution of the gas permeation equation provides the pressure inside a microsphere as a function of time. The time frame examined is 10^{-3} to 1 sec at 3000°K. The results indicate that inward diffusion of N_2 and O_2 from the reactant environment accounts for partial pressures of 0.1 and 2 torr (measured at 300°K), respectively, if the microsphere is initially devoid of gas. No significant outward diffusion occurs if the microsphere initially contains 1 atmosphere of N_2 and O_2. These calculational results are compared with earlier mass spectrometric analyses of gases contained in the microspheres. Only N_2 was detected experimentally, at pressures ranging from 1 to 40 torr, measured at 300°K. It is concluded, therefore, that the presence of N_2 in the microspheres is not a product of diffusion and that N_2 is a principal component of the gas release mechanism for microsphere formation. (auth)

22655 STRENGTH, FRACTURE MODE, AND THERMAL STRESS RESISTANCE OF HfB_2 AND ZrB_2. Kalish, David; Clougherty, Edward V.; Kreder, Konstantine (ManLabs, Inc., Cambridge, Mass.). J. Amer. Ceram. Soc., 52: 30-6(Jan. 21, 1969).

Zirconium diboride and hafnium diboride were fabricated by hot-pressing at 1800°C and 120,000 psi. Bend strengths were measured on the fully dense materials from 25 to 1400°C in an argon atmosphere. These diboride compounds did not exhibit any gross plastic flow in the temperature range studied. The bend strengths went through a maximum between 700 and 1000°C and varied from 39,000 to 68,000 psi for HfB_2 and 30,000 to 56,000 psi for ZrB_2. The maxima in strength corresponded to maxima in the fraction of transgranular fracture. The bend strength and room-temperature elastic modulus measurements were combined with available thermal conductivity and expansion data to calculate thermal stress resistance parameters. Under steady-state heat flow conditions, the calculated thermal stress resistance parameters of the borides were higher than those calculated for other refractory compounds. (auth)

22656 DEPENDENCE OF FLOW STRESS ON NONSTOICHIOMETRY IN OXYGEN-RICH URANIUM DIOXIDE AT HIGH TEMPERATURES. Nadeau, J. S. (General Electric Research and Development Center, Schenectady, N. Y.). J. Amer. Ceram. Soc., 52: 1-7(Jan. 21, 1969).

The compressive flow stresses of UO_{2+x} polycrystals and single crystals were measured between 900 and 1600°C. The stoichiometry was controlled by CO_2/CO gas mixtures during the tests. The functional dependence of strength on stoichiometry was: $\sigma = Cx^{-m}$

where C and m are constant at a constant temperature and $0.001 \leq x \leq 0.25$. In stoichiometric crystals there was a marked anisotropy in strength. The $\{100\} \langle 110 \rangle$ systems were much softer than the $\{1\bar{1}0\} \langle 110 \rangle$ systems, and the latter seemed to determine the strength of polycrystals. The harder systems $\{1\bar{1}0\} \langle 110 \rangle$ displayed a greater temperature dependence of flow stress than the softer ones. Nonstoichiometry largely removed the anisotropy in strength and temperature dependence. It is suggested that the rate-controlling deformation mechanism for polycrystals may be the thermally activated surmounting of the Peierls barrier. (auth)

22657 CUBIC CARBIDES, NITRIDES, AND OXIDES OF THE FIRST TRANSITION-METAL SERIES. Petru, F.; Brozek, V. Pokroky Praskove Met. VUPM, No. 4, 3-27(1967). (In Czech).

The technology of carbides, nitrides, and monoxides of the first transition-metal series is discussed from the viewpoint of atomic bonds. Attention is paid to compounds of Sc, and these are compared with analogous compounds of Ti, V, and Cr. The results of studies of chemical structure, atomic constants, homogeneity, and electron structure are discussed. (F.S.)

22658 THE THERMAL CONDUCTIVITY OF AGOT GRAPHITE BETWEEN 0.3 AND 3^{0}K. Edwards, D. O.; Sarwinski, R. E.; Seligmann, P.; Tough, J. T. (Ohio State Univ., Columbus). Cryogenics, 8: 392-3(Dec. 1968).

The thermal conductivity of AGOT grade graphite was measured parallel to the extrusion direction, and the results are shown. The data fit a conductivity of the form $K = \alpha T^n$ with $\alpha = 49$ erg/s cm $K^{(n+1)}$ and $n = 1.86$. (UK)

22659 CRYSTAL STRUCTURE OF THE HEXAGONAL PHASE $ThMo_2O_8$ AT HIGH TEMPERATURE. Thoret, Jean; Rimsky, Alexandre; Freundlich, William (Laboratoire de Chimie Minerale de la Sorbonne, Paris. CNRS, Paris). Compt. Rend., Ser. C, 267: 1682-4(Dec. 16, 1968). (In French).

The high-temperature hexagonal phase of $ThMo_2O_8$ was prepared, and positions of atoms in the lattice were determined from the reticular complex and study of the vector diagram of Patterson. The results are tabulated. The structure is projected on the (001) plane. Analogous configurations were found for those previously reported for $HfMo_2O_8$. (J.S.R.)

22660 CRYSTAL STRUCTURE OF THE $WV_2O_{7.5}$ PHASE. Mondet, Suzanne (Laboratoire de Chimie Minerale, Paris). Compt. Rend., Ser. C, 267: 1689-91(Dec. 16, 1968). (In French).

The crystalline structure of the quadratic phase $WV_2O_{7.5}$ was studied. The parameters are a = 1950 Å, c = 3.70 Å, and it belongs to the space group I(4/m)mm. The positions of the heavy atoms were determined, and an octahedric configuration of the oxygen atoms was placed around the tungsten and vanadium atoms. The interatomic distances were measured. The structure is analogous to that determined in the $Nb_2O_5-WO_3$ system. (J.S.R.)

22661 THERMAL CONDUCTIVITY OF ThO_2-UO_2 SYSTEM. Murabayashi, Masayuki (Tokyo Univ.); Namba, Susumu; Takahashi, Yoichi; Mukaibo, Takashi. J. Nucl. Sci. Technol. (Tokyo), 6: 128-31(Mar. 1969).

The thermal diffusivity of the ThO_2-UO_2 system in solid solution was measured using a laser pulse at 20 to 500°C. Reproducibility of the data was confirmed to be within 3%. The compositions of the samples were ThO_2, $ThO_2-1\%UO_2$, $ThO_2-5\%UO_2$, and $ThO_2-10\%UO_2$. The thermal conductivity was calculated from measured thermal diffusivity data and the specific heat data available in literature and corrected to zero porosity by using Loeb's equation, in which the shape factor is unity. The values on ThO_2 thus obtained agreed very well with the data found in literature. The thermal conductivity of ThO_2, $ThO_2-1\%UO_2$, $ThO_2-5\%UO_2$, and $ThO_2-10\%UO_2$, at 20°C, were 0.0312, 0.0288, 0.247, and 0.0184 cal · cm/sec · °C · cm^2, respectively. (auth)

22662 STUDY OF DIFFUSION OF BARIUM IN VARIOUS CARBONS BY ELECTRON MICROPROBE. Suzuki, Hiroshige (Tokyo Inst. of Tech.); Kimura, Shiushichi; Matsui, Minoru. J. Nucl. Sci. Technol. (Tokyo), 6: 107-12(Mar. 1969).

The diffusion of Ba carbon was investigated by electron microprobe analyzer. The analysis was carried out on an instantaneous source experiment. Diffusion coefficients were obtained by slope of log C vs. X^2, total amount of diffusion substances, and coordinate of the point of inflexion in the concentration penetration curve. The diffusion coefficients and activation energies obtained were in accord with the magnitude expected from the structure of impermeable carbons. The method can be considered as effective as out-pile tests for analyzing the diffusion mechanism of fission products. (auth)

22663 ANISOTROPIC THERMAL EXPANSION OF ZIRCONIA. Davies, M. (Morganite Research and Development Ltd., London). pp 229-36 of Special Ceramics 4. Popper, P. (ed.). Stoke-on-Trent, Eng., British Ceramic Research Association, 1968.

From 4th Symposium on Special Ceramics, Stoke-on-Trent, England. See CONF-670731.

The axial thermal expansion of zirconia was accurately determined in the temperature range 20–1100°C by X-ray diffraction techniques, and the results were found to differ from previously reported data. Between 20° and 300°C the b-axis of the monoclinic cell contracts. This finding is discussed, and it is suggested that the irregular ZrO_7 units which form the structure attain a more regular configuration. Above 300°C the expansion along all axes is reasonably uniform up to the transition temperature. The bulk thermal expansion coefficients calculated from the axial measurements agree well with other published data. (auth) (UK)

22664 THERMAL STRESSES IN PYROLYTIC DEPOSITS. Ruddlesden, S. N. (British Ceramic Research Association, Stoke-on-Trent, Eng.). pp 153-63 of Special Ceramics 4. Popper, P. (ed.). Stoke-on-Trent, Eng., British Ceramic Research Association, 1968.

From 4th Symposium on Special Ceramics, Stoke-on-Trent, England. See CONF-670731.

The stresses in pyrolytic deposits on rods and on the outside or inside of hollow cylinders arising from the thermal expansion mixmatch between deposit and substrate are considered. Particular reference is made to deposits of silicon carbide on graphite and to factors leading to cracking. The effect of anisotropy of thermal expansion of the graphite is included. (auth) (UK)

22665 PROPERTIES AND SINTERING BEHAVIOUR OF THORIUM OXIDE PRODUCED BY CALCINATION OF THORIUM OXALATE. Warren, D.; Elyard, C. A. (Associated Electrical Industries Ltd., Rugby, Eng.). pp 57-68 of Special Ceramics 4. Popper, P. (ed.). Stoke-on-Trent, Eng., British Ceramic Research Association, 1968.

From 4th Symposium on Special Ceramics, Stoke-on-Trent, England. See CONF-670731.

Thorium oxide was prepared by calcining thorium oxalate in air at temperatures between 500° and 1300°C. The resulting powders were characterized by means of their B.E.T. area and electron-microscope studies. The powder particles were observed to have a clearly defined crystallite structure. The crystallite size was 100 Å for powders calcined at 500°C and 2700 Å for the powders calcined at 1300°C. The sintering behavior of the powders at temperatures up to 1750°C was examined using a dilatometer. It was found that densification of powder compacts commenced at about the temperature at which the powder had been calcined and was beginning to level off by 1400°C. At higher temperatures there was evidence of further densification. (auth) (UK)

22666 PREPARATION OF GRAPHITE MATRIX FUELS CONTAINING THORIUM CARBIDE. Oikawa, Takashi (Showa Denko K. K., Tokyo); Hanaoka, Teruo. J. Nucl. Sci. Technol. (Tokyo), 6: 120-7(Mar. 1969).

The properties and structure of fuel samples prepared by compacting various mixtures of powdered material followed by heating were investigated. It was found that of the resulting compacts those consisting of purified and milled natural graphite powder, metallic thorium powder and furfuryl alcohol binder showed the best properties after heating to 600°C. These compacts possessed 1.90 ~ 2.40 g/cc density, 3.5 ~ 10.0 kg/mm^2 Vickers hardness, a thermal expansion coefficient at 900°C of about 14×10^{-6}/°C in the direction parallel to, and 2.5×10^{-6}/°C normal to pressing direction, and a thermal conductivity, in the same temperature range, of 0.02 (parallel) and 0.07 cal/cm · sec°C (normal). Since these favorable properties and structural features are not impaired by heating to about 2,000°C subsequent to treatment at 600°C, it can be said that a new, simple and effective set of conditions for fuel preparation has been found. (auth)

22667 PREPARATION AND PROPERTIES OF ThP AND ThP–UP SOLID SOLUTIONS. Baskin, Y. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 52: 54-5(Jan. 21, 1969).

The synthesis of ThP by the reaction of finely divided Th with PH_3 gas was described. Results of oxidation studies of ThP were illustrated by DTA and TGA curves. Lattice parameters and melting points of ThP and ThP–UP solid solutions were determined. (G.M.C.)

22668 DISCUSSION OF THE DIFFUSION MECHANISM IN GRAPHITE WITH PARTICULAR REFERENCE TO IRRADIATED MATERIAL. Roscoe, C. (Pennsylvania State Univ., University Park). Carbon, 7: 119-27(Feb. 1969).

Principally due to doubt concerning the activation energy of intersitital formation, E_f^i, it has been difficult to differentiate between an intersititial and vacancy mechanism for self-diffusion in graphite. However, the recent studies of Turnbull and Stagg, which were verified by Thrower, yield a value of 8.3 ± 0.3 eV for the activation energy of diffusion occurring both in pyrolytic and naturally occurring graphites. This value was identified with $E_f + \frac{1}{2}(E_{ma} + E_{mc})$. By considering the structural perfection of the graphites employed it is concluded that there is no necessity to assume a discrete value describing E_{mc}. Rather the observed activation energy, E*, is interpreted as the summation of $\frac{1}{2}(E_f^i + E_f^v) + E_{ma}^i$, which implies that self diffusion occurs via a dynamic interchange mechanism. It is implicit for the operation of this mechanism that the matrix should contain sites of high vacancy concentrations, such as intercrystallite boundaries. If the value of E_f^v is assumed to be 7.0 ± 0.5 eV, the values of 8.8 ± 0.6 and 9.4 ± 0.6 eV are derived for E_f^i, when the experimental and theoretical values of E_{ma}^i are substituted, respectively. The latter number is in fairly close agreement with both Coulson's theoretical value and that determined experimentally by Murty (9.6 ± 0.8 eV). (auth) (UK)

22669 DEFECT CONTRIBUTION TO THE EXCESS ENTHALPY OF URANIUM DIOXIDE-CALCULATION OF THE FRENKEL ENERGY. Szwarc, R. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Phys. Chem. Solids, 30: 705-11(Mar. 1969).

An equation for the enthalpy of UO_2 was derived from earlier data. It is comprised of a lattice parabolic segment to which was added an enthalpy exponential term: $H_T = -5601.5 + 17.78T + 1.02 \times 10^{-3}T^2 + 71300\sqrt{2}\ \exp(14.83/2R)\ \exp(-71300/2RT)$. This equation agrees well with the experimental data up to the melting point of UO_2. The formation energy and entropy of Frenkel pairs in UO_2 were derived from the high temperature data as 71,300 ± 2.200 cal mole^{-1} and 14.83 ± 0.84 cal mole^{-1} deg^{-1}, respectively. The model is based upon the assumption that disordering occurs on the oxygen sublattice only and that oxygen Frenkel defects predominate. (auth)(UK)

22670 MECHANICAL PROPERTIES OF EGCR-TYPE AGOT GRAPHITE. Greenstreet, W. L.; Smith, J. E.; Yahr, G. T. (Oak Ridge National Lab., Tenn.). Carbon, 7: 15-45(Feb. 1969).

Mechanical properties of a coarse-grained nuclear graphite, designated EGCR-type AGOT, obtained from tests at room temperature, 1000, 2000, and 4500°F are described. The main emphasis is, however, on room temperature results; these include stress and lateral strain vs. longitudinal strain curves. Size effect and stress gradient influences upon the material behavior were studied, and two important conclusions reached. These were that size effects, including volume and cross-sectional area, were small or nonexistent within the size range investigated, and that the behavior was the same in flexural and in uniaxial tests. (auth)(UK)

22671 NEUTRON DIFFRACTION STUDY OF NpC. Lander, G. H.; Heaton, L.; Mueller, M. H.; Anderson, K. D. (Argonne National Lab., Ill.). J. Phys. Chem. Solids, 30: 733-7(Mar. 1969).

A neutron diffraction investigation of polycrystalline NpC confirmed the conclusions from measurements of magnetic susceptibility that the compound is antiferromagnetic between 310 and 220°K, and ferromagnetic below 220°K. Neptunium carbide has the NaCl type structure (a = 4.992 Å); the antiferromagnetic structure consists of ferromagnetic layers perpendicular to [001] coupled antiferromagnetically with the spin direction along the [001] axis. The change in ordered moment in the antiferromagnetic region below 310°K does not follow a Brillouin function. The maximum moment in the antiferromagnetic state is 1.3 ± 0.1 μ_B. The magnetic form factor for the neptunium atom was also determined at low angles. The transition to ferromagnetism is probably first order, and the initial moment at 218°K is 1.6 μ_B. The moment increases to a maximum value of 2.1 ± 0.1 μ_B at ~150°K and remains constant down to 6°K. (auth) (UK)

22672 SOLID SOLUTIONS AND POLYMORPHISM IN THE ZrO_2-HfO_2 SYSTEM. Gavrish, A. M.; Sukharevskii, B. Ya.; Krivoruchko, P. P.; Zoz, E. I. (Ukrainian Scientific-Research Inst. of Refractory Materials, Kharkov). Izv. Akad. Nauk SSSR, Neorg. Mater., 5: 547-50(Mar. 1969). (In Russian).

Formation of solid solutions of ZrO_2 with various concentrations of HfO_2, compressed into tablets and annealed at 1750°C in the air was studied. X-ray and petrographic analysis showed that additions of HfO_2 influenced, significantly, the temperature characteristics of polymorphic transitions in ZrO_2 (increasing the temperature and transition intervals). (R.V.J.)

22673 CHEMISORPTION OF HYDROGEN ON TANTALUM MONOCARBIDE. Gasser, R. P. H.; Gowan, P. M.; Newman, D. G. (Oxford Univ.). Surface Sci., 14: 7-12(Mar. 1969).

A filament of tantalum monocarbide was found to chemisorb hydrogen with an uptake that was independent of the pressure of hydrogen between 1.5 × 10^{-8} Torr and 1.6 × 10^{-7} Torr. The rate of adsorption had a first order dependence on the pressure of hydrogen and the reaction was nonactivated. The sticking probability declined linearly with increasing uptake of hydrogen, from which it was concluded that no mobile, physisorbed precursor to chemisorption was formed. (auth)

22674 MASS-SPECTROMETRIC EVIDENCE FOR THE MOLECULES UC AND CeC AND PREDICTED STABILITY OF DIATOMIC CARBIDES OF ELECTROPOSITIVE TRANSITION METALS. Gingerich, Karl A. (Texas A and M Univ., College Station). J. Chem. Phys., 50: 2255-6(Mar. 1, 1969).

The molecules UC(g) and CeC(g) were found and identified in the equilibrium vapor of condensed systems at high temperatures. Experimental values of the dissociation energies of these diatomic molecules were determined and were found to agree with calculated energy values. Dissociation energies of the diatomic carbides of some other electropositive transition metals were calculated. (G.M.C.)

22675 VOLATILIZATION CHARACTERISTICS OF URANIUM MONONITRIDE. Alexander, C. A.; Ogden, J. S.; Pardue, W. M. (Battelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. J. Nucl. Mater., 31: 13-24(May 1969).

Experiments have been performed by transpiration, vacuum microbalance, effusate collection, and mass spectrometry to determine mass transport in uranium mononitride. Under equilibrium conditions uranium mononitride will preferentially lose nitrogen, and molten uranium will be a product at all temperatures above the melting point of uranium. Under dynamic vacuum conditions, however, nitrogen vaporization is markedly curtailed probably as a result of the slow rate of diffusion of nitrogen through uranium mononitride. Under dynamic conditions, it is possible to vaporize UN without the accumulation of molten uranium on the surface. The transpiration determinations of vaporization of UN have been utilized in a thermodynamic cycle to establish a value of 126 kcal/mole as the standard heat of vaporization of uranium. This value was further substantiated by effusate collection which yielded a value of 126.5 kcal/mole for the heat of vaporization of uranium. It is indicated that the UN homogeneity range extends to $UN_{0.97}$ at 1600°C and approaches $UN_{0.98}$ at 1700°C. Across the portion of the homogeneity range of UN that was examined the activity of uranium changes by a factor of about a thousand at these temperatures. (auth)

22676 MELTING POINT MAXIMA OF ThC–ThN AND OF UC–UN SOLID SOLUTIONS. Benz, R. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 31: 93-8(May 1969).

Melting points of ThC-ThN and UC-UN mixtures in nitrogen atmospheres were determined. Maxima occur at 2910 ± 35°C with the compositions $ThC_{0.35}N_{0.65 \pm 0.1}$ and $UC_{0.3}N_{0.7 \pm 0.1}$. From a determination of the nitrogen activity the excess free energies of mixing the terminal mononitrides at 2820°C in the respective pseudobinary solid solutions are inferred to be −3.2 ± 2.0 kcal/mole at the ThN mole fraction of 0.45 and −0.7 ± 1.5 kcal/mole at the UN mole fraction of 0.50. (auth)

22677 REDISTRIBUTION OF CARBON IN URANIUM ALLOYS TREATED AT HIGH TEMPERATURE. Giraud-Heraud, Francois (Laboratoires de Veurey, Isere, France). Compt. Rend., Ser. C, 268: 922-5(Mar. 10, 1969). (In French).

The redistribution of carbon in uranium and in its alloys treated under vacuum at high temperature was studied. The different aspects of the phenomenon, selective growth of the carbon dendrites during the first stages of the treatment on the one hand and internal decarburization of the samples and growth of a superficial layer of carbon on the other hand, were interpreted by the aid of a simple model of coalescence. (tr-auth)

Structure and Phase Studies

Refer also to abstracts 22636, 22641, and 22671.

22678 (ANL-Trans-728) TERNARY OXIDES OF PENTA- AND HEXAVALENT NEPTUNIUM AND PLUTONIUM WITH LITHIUM AND SODIUM. Koch, Lothar (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Translated for Argonne National Lab., Ill., from report KFK-196. 64p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 18: 27358. (TSS)

22679 CUPRIC OXIDE–MOLYBDENUM OXIDE PHASE DIAGRAM IN AIR AND IN OXYGEN. Nassau, K.; Shiever, J. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Amer. Ceram. Soc., 52: 36-40(Jan. 21, 1969).

Phase diagrams of the CuO–MoO_3 system were determined in oxygen, in air, and under oxygen pressure. The first two diagrams are quite similar, with temperatures up to 40° higher occurring in oxygen than in air. Stable compounds obtained by low-temperature sintering were $CuMoO_4$ and Cu_2MoO_5, which melted incongruently at 835 and 880° in oxygen and at 812 and 840°C in air, respectively. The MoO_3–$CuMoO_4$ eutectic occurred near 30 mol % CuO at 705 in oxygen and at 700°C in air. Above temperatures as low as 865 in oxygen and 840°C in air, oxygen was lost with the production of cuprous compounds. This phenomenon probably accounts for all of the inconsistencies in previous phase diagrams. The dominant cuprous compound in the central region at high temperatures was $Cu_6Mo_4O_{15}$, melting congruently at 880 and 895°C in air and oxygen, respectively. On cooling in oxygen-contained atmospheres, this compound changed to cupric $Cu_3Mo_2O_9$. Unit cell dimensions and an indexed powder pattern are presented for this compound. Experiments under an oxygen pressure of 2 to 3 atm indicated that the cupric compounds in the simple CuO–MoO_3 system without reduction were $CuMoO_4$, $Cu_3Mo_2O_9$, and Cu_2MoO_5, melting incongruently at 850, 910, and 940°C, respectively. In all atmospheres $Cu_3Mo_2O_9$ was metastable with respect to $CuMoO_4$ and Cu_2MoO_5 below the incongruent melting point of $CuMoO_4$. (auth)

22680 ELECTRONIC RAMAN EFFECT IN PARAMAGNETIC CRYSTALS: $CeCl_3$. Kiel, A.; Damen, T.; Porto, S. P. S.; Singh, S.; Varsanyi, F. (Bell Telephone Labs., Holmdel, N. J.). Phys. Rev., 178: 1518-24(Feb. 15, 1969).

A study of the electronic states of the f^1 configuration of $CeCl_3$ was conducted, using the electronic Raman effect. The use of this technique for studying far-infrared electronic states proved to be simpler than other methods, particularly when phonon states are nearby. The general features of the electronic Raman effect are discussed, including pseudovector scattering terms and asymmetric scattering intensity. Both of these latter effects have been observed in experiments. The intensities of all lines have been calculated and are in reasonable agreement with the observations. In the case of the lines showing asymmetry in intensity, the orientation for maximum intensity as well as the magnitude of asymmetry can be predicted. The phonon spectrum of $CeCl_3$ is briefly discussed. One of the phonon lines showed a small but definite asymmetry in intensity. This particular phonon line seems to interact with the strongest electronic Raman line. (auth)

22681 THE PHASE DIAGRAM OF THE SYSTEM WO_3–UO_3. Cordfunke, E. H. P. (Reactor Centrum Nederland, Petten). J. Inorg. Nucl. Chem., 31: 1542-3(May 1969).

A double oxide of the composition UO_2WO_4 was reported in this system, with a monoclinic crystal symmetry (space group P 2_1/C; a = 7.205 Å, b = 5.482 Å, c = 13.57 Å, β = 104° 35′). From experiments to prepare this compound by calcining the oxides in air at about 1000°C, it was found that it has the rather low melting point of ~1100°C. In an experimental examination of the phase diagram of the system only one double oxide phase was found, of which the x-ray diagram was that reported previously, and no phase changes were observed. From the phase diagram presented it is seen that the double oxide has the approximate composition $WO_3 \cdot UO_3$ at the eutectic temperature of 1060°C. The melting point is incongruent and at 1098°C, at which temperature the equilibrium WO_3/UO_3 ratio is about 0.981. Due to evaporation of WO_3 preparation of the stoichiometric double oxide is best effected by heating the mixture of oxides in a closed tube and in a platinum crucible at about 850 to 900°C. (UK)

22682 CRYSTALLOGRAPHIC CHARACTERISTICS OF THE SOLID SOLUTIONS $Sr_3[U_xW_{1-x}Fe_2]O_9$. Seveque, Francois; Dianoux, Albert-Jose; Poix, Paul (Laboratoire de Chimie Minerale, Orsay, France). Compt. Rend., Ser. C, 268: 165-6(Jan. 13, 1969). (In French).

Study of the solid solutions $Sr_3[U_xW_{1-x}Fe_2]O_9$ showed the passage for x in the neighborhood of 0.52 from an ordered phase of type $Sr_3UFe_2O_9$ to a disordered phase of type $Sr_3WFe_2O_9$. The disappearance of the crystallographic order was accompanied by the disappearance of spontaneous magnetization. (tr-auth)

22683 PHASE EQUILIBRIA IN THE URANIUM OXIDE–RARE EARTH OXIDE SYSTEMS (Ho, Er, Tm, Yb, Lu). Keller, C.; Engerer, H.; Leitner, L.; Sriyotha, U. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 31: 965-80(Apr. 1969). (In German).

The subliquidus equilibria of the systems uranium oxide–oxides of the rare earths (RE = Ho, Er, Tm, Yb, Lu) were investigated in detail between 1100 and 1550°C at $p(O_2)$ = 1 atm. It was found that all systems possess four one-phase regions separated by the corresponding two-phase regions. The one-phase regions are: U_3O_8, and fluorite, rhombohedral, and C-type phases. No solubility of $ReO_{1.5}$ in U_3O_8 could be detected. In the uranium-rich part the extension of the fluorite phase increases with temperature, while in the rare earth-rich part the limiting value around 64 mole % $ReO_{1.5}$ shows no dependence on temperature. The 1 : 1 reaction products $(U_{0.5}, RE_{0.5})O_{2.00}$ have a remarkable thermal stability. A rhombohedral phase with hexavalent uranium exists from about 72 mole % $REO_{1.5}$ up to the 1 : 6 compound $UO_3 \cdot 6REO_{1.5}$. The solubility of uranium oxide in the rare earth oxides is very small and decreases with increasing temperature. ir spectra taken from different phase regions give no reference to UO_2^{2+}-groupings in the mixed oxides. (auth)(UK)

22684 A THERMODYNAMIC STUDY OF THE ZIRCONIUM–SULFUR SYSTEM IN THE REGION $ZrS_{1.40}$ TO $ZrS_{2.00}$. Larson, A. H.; Schlechten, A. W. (Colorado School of Mines, Golden). Met. Soc. Conf., 34: Pt. 1, 397-408(1968).

From Conference on High Refractory Metals, New York. See CONF-650227–(Pt.1).

Equilibrium H_2S/H_2 ratios were determined as functions of temperature at 500 to 900°C and composition in a hydrogen circulation apparatus. Within the composition range studied there exists a two-phase region of Zr_3S_4 and ZrS_2. The upper composition limit of this two-phase region is bounded by a disulfide phase and is practically constant over the temperature range investigated. The lower composition limit of this two-phase region is bounded by a Zr_3S_4 phase and varies appreciably with temperature. The upper composition limit of the homogeneous region of the disulfide phase is not definitely determined, but it appears to be bounded by the stoichiometric composition of ZrS_2. The lower composition limit of the homogeneous region of the Zr_3S_4 phase could not be determined due to the extremely low values of the equilibrium H_2S/H_2 ratios. Various thermodynamic quantities are evaluated from the data. (auth)

22685 A THERMODYNAMIC ANALYSIS OF THE Ta–C–O, Cb–C–O, AND V–C–O SYSTEMS. Worrell, Wayne L.; Chipman, John (Massachusetts Inst. of Tech., Cambridge). Met. Soc. Conf., 34: Pt. 1, 335-45(1968).

From Conference on High Refractory Metals, New York. See CONF-650227–(Pt.1).

Using recent thermodynamic data for the carbides and oxides of tantalum, niobium, and vanadium, the stable solid phases above 1300°K and at one atmosphere CO(g) pressure in each M–C–O system have been determined. Pourbaix–Ellingham diagrams have been constructed and are used to estimate the minimum temperatures necessary to obtain these metals by carbothermic reduction under reduced pressures. (auth)

22686 HIGH-TEMPERATURE INVESTIGATIONS OF TRANSFORMATIONS IN A MIXTURE ZIRCONIUM DIOXIDE–IRON OXIDES. Bessonov, A. F.; Taksis, G. A. Zh. Fiz. Khim., 43: 251-3(Jan. 1969). (In Russian).

Phase transformations were studied in a mixture of zirconium dioxide with iron oxides. Changes in the linear dimensions of the samples were coordinated with the processes that occur on heating of the sample. A qualitative picture of the phase transformations that occur in the mixture in air at atmospheric pressure and with continuous heating up to 1500°C is given. (tr-auth)

22687 DISLOCATIONS IN CUBIC URANIUM OXIDE. Blank, H.; Ronchi, C. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 31: 1-12(May 1969). (In German).

The behavior of entire dislocations in {100}-, {110}- and {111}-glide planes in UO_2 is discussed with respect to the geometry of the fluorite structure and compared with results of transmission electron microscopy. Interstitial and vacancy loops on {110} planes under normal conditions exist without stacking faults. Dislocations in the phase boundaries between UO_2 and U_4O_9 are only found after drastic heat treatment of the specimen in the electron microscope. This indicates that at least below about 300°C dislocation can only be produced with difficulty in these oxides. Because of the low atomic density in {111} planes partial dislocations preferentially move in more complicated crystallographic planes than {111} planes giving rise to noncrystallographic slip. Stacking faults in {111} planes of the fluorite structure cannot be classified as intrinsic or extrinsic like in close packed metals but in any case consist of a combination of both types. (auth)

22688 THE STRUCTURE OF Ru_2B_3 AND WB_2 AS DETERMINED BY SINGLE-CRYSTAL DIFFRACTOMETRY, AND SOME NOTES ON THE W–B SYSTEM. Lundstroem, Torsten (Uppsala Univ.). Ark. Kem., 30: 115-27(1969).

The crystal structure of Ru_2B_3 and WB_2 (of the W_2B_5 type structure) was investigated by single-crystal diffractometer. In Ru_2B_3 there are isolated boron atoms coordinating metal atoms only, as well as puckered two-dimensional networks of boron atoms. In WB_2 the boron atoms form both planar and puckered networks. In these structures the boron atoms never have more than three close boron neighbors. Cell dimensions for earlier reported phases in the W-B system were measured in the two-phase regions. A revision is proposed for the phase diagram for the W-B system. (Sweden)

22689 INVESTIGATIONS IN THE TWO-COMPONENT SYSTEMS La_2O_3–(CaO, SrO, BaO). Purt, G.; Modern, E. (Fa. Cerberus AG, Maennedorf, Switzerland). Monatsh. Chem., 99: 2171-4(Nov.-Dec. 1968). (In German).

The incorporation of lanthanum oxide into CaO, SrO, and BaO was studied by x-ray methods. The incorporated quantities of La_2O_3 in samples decarbonized at 1000°C were found to be 1 mol % for BaO, 2.4 mol % for SrO, and no solubility for CaO. (auth)

Radiation Effects

Refer also to abstracts 22612, 22640, 23825, and 23849–23856.

22690 (GAMD-9245) SUMMARY COMPILATION OF GULF GENERAL ATOMIC COATED PARTICLE IRRADIATION EXPERIMENTS. Harmon, D. P. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 30, 1968. Contract AT(04-3)-633. 24p. Dep. CFSTI.

Summary tables are presented which describe coated particle irradiation experiments, both current and completed. The tables include descriptions of the samples tested, irradiation conditions (actual or design), and results of postirradiation examinations for completed experiments. These tables contain the best available data as of December 1968 and supersede all previous tables. (auth)

22691 STUDIES OF RADIATION DAMAGE IN DEGENERATE SILICON IRRADIATED AT LOW TEMPERATURES. Sivo, L. L.; Klontz, E. E. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 178: 1264-73(Feb. 15, 1969).

Pulled (Czochralski) and float-zone n-type (NC,NF) and p-type (PC,PF) degenerate Si samples were irradiated at 10 to 140°K 1-MeV electrons, and were studied by observing changes which occur in the dc conductivity σ and Hall coefficient R_H as a result of bombardment and various thermal treatments. For PC and PF, carrier removal rates remained practically constant at 0.7 and 1.1 cm^{-1}, respectively, for irradiation temperatures between 7 and 90°K. In contrast, NC and NF removal rates increased nearly exponentially with irradiation temperature above approximately 60°K, while below $\approx$60°K they were exceedingly small (<0.02 cm^{-1}). Radiation-induced recovery due to 350-keV electrons was observed in n-type Si. This effect exhibits a strange temperature dependence, being quite efficient below a characteristic temperature and very inefficient above that temperature. The kinetics of radiation annealing at a given temperature is a superposition of two first-order processes. The metastable-pair model is compared with one based on a mobile interstitial. Defects introduced into degenerate Si at low temperatures show high resistance to thermal annealing, in contrast to the behavior of nondegenerate material. Isochronal annealing runs indicate that complete recovery occurs only around 1000°K. Some of the recovery stages are tentatively identified with specific defect structures previously reported in the literature. Detailed results of isothermal annealing experiments in the first recovery stage of p-type Si (295 to 265°K) are given. (auth)

22692 ANISOTROPY OF THE OPTICAL CONSTANTS AND THE BAND STRUCTURE OF GRAPHITE. Greenaway, D. L. (RCA Labs. Ltd., Zurich); Harbeke, G.; Bassani, F.; Tosatti, E. Phys. Rev., 178: 1340-8(Feb. 15, 1969).

Results were obtained on the reflectivity of both natural and pyrolytic graphite single crystals in the visible and ultraviolet regions. Results were taken for both $E \perp c$ and $E \parallel c$ at near-normal incidence, and as a function of angle of incidence for radiation having its electric vector both perpendicular and parallel to the plane of incidence. These latter results, used in conjunction with an analysis of the Fresnel relations for anisotropic materials, permit extremely accurate values of the optical constants to be obtained both parallel and perpendicular to the crystal planes. The results show that $k_{\parallel}$, the absorption index perpendicular to the cleavage planes, is identically equal to zero at all energies below about 5 eV, as expected from the two-dimensional approximation of the energy bands in graphite. A three-dimensional calculation is performed to explain the above picture. The optical constants obtained explain the electron-energy-loss experiments on graphite and require the absence of the low-energy plasmon along the c axis. The newly developed Fresnel analysis presented can find general application to all highly anisotropic materials. (auth)

22693 FARADAY ROTATION STUDIES OF AN R-LIKE CENTER IN NEUTRON-IRRADIATED MgO. II. THEORY. Glaze, James A.; Kemp, James C. (Univ. of Oregon, Eugene). Phys. Rev., 178: 1507-17(Feb. 15, 1969).

Results show that the R-like center associated with the zero-phonon transition at 5233 Å in neutron-irradiated MgO is paramagnetic (spin-½). In addition, these results indicate that the orbital angular momentum that is to be associated with the degenerate E ground state is highly quenched. It is believed that this quenching arises primarily from splitting of the E ground state by the random strain field of the bulk crystal, and a coupling of this E state to a pair of degenerate vibrational modes through the Jahn–Teller effect. An expression for the Faraday angle was developed which incorporates these two quenching mechanisms. The observed temperature and magnetic field dependence as well as the spectral pattern of the Faraday angle will be explained on the basis of the assumed model. The results were used to make the following estimates: $1\ cm^{-1} \lesssim \lambda_R \lesssim 2\ cm^{-1}$, and $\alpha\Delta \lesssim 0.07$, where λ_R and $\alpha\Delta$ are the spin-orbit splitting and reduced orbital angular momentum, respectively, associated with the degenerate ground state. (auth)

22694 FARADAY ROTATION STUDIES OF AN R-LIKE CENTER IN NEUTRON-IRRADIATED MgO. I. EXPERIMENTAL. Glaze, James A.; Kemp, James C. (Univ. of Oregon, Eugene). Phys. Rev., 178: 1502-7(Feb. 15, 1969).

The zero-phonon line at 5233 Å appearing in neutron-irradiated MgO has been shown by other workers to be consistent with an $E \rightarrow A$ electronic transition within a center possessing trigonal symmetry about the [111] direction. (The position of this line has previously been fixed at 5248 Å. It was found to occur at 5233 Å. The optical Faraday effect was used to study this transition for temperatures in the range 1.60 to 4.22°K. It is shown, by examination of the temperature and magnetic-field dependence of the Faraday angle, that the line at 5233 Å is associated with a "spin-½" paramagnetic center. The Faraday angle is shown to vary as 1/T in the range 1.81 to 4.22°K for fields less than 10 kG. The field dependence is linear up to 40 kG at 4.22°K, but at 1.81°K it shows strong saturation behavior from 10 to 55 kG. It is found that the Faraday angle may be described by the relation $\theta = B \tanh (g\beta H/2kT)$, with $g = 1.9 \pm 0.1$. Since the value of g is close to that for a free electron, it appears that the electronic orbital angular momentum that is to be associated with the degenerate E ground state is highly quenched. The spectral pattern of the Faraday angle is dispersionlike in nature, which is further evidence for orbital quenching. The relative sign of the rotation pattern is opposite to that of the F-center in CaO and MgO. Unlike the similar result for the R-center in the alkali halides, this inversion is indicative of a center whose spin-orbit coupling constant is positive, and on the basis of a simple molecular-orbital approach, it is consistent with a five-electron center possessing a hole in its (1e) orbital. (auth)

22695 GRAPHITE BEHAVIOR AND ITS EFFECTS ON MSBR PERFORMANCE. Kasten, P. R.; Bettis, E. S.; Cook, W. H.; (and others). (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 9: 157-95(Feb. 1969).

Graphite behavior under Molten-Salt Breeder Reactor (MSBR) conditions is reviewed and its influence on MSBR performance estimated. Based on the irradiation behavior of small-sized graphite specimens, a permissible reactor exposure for MSBR graphite is about 3×10^{22} neutrons/cm^2 (E > 50 keV). The stresses generated in the graphite due to differential growth and thermal gradients are relieved by radiation-induced creep, such that the maximum stress during reactor exposure is less than 1000 psi for reactor designs having a peak core power density of about 100 kW/liter and reactor exposures less than about 2½ yrs. The corresponding power costs for single-fluid MSBR's would be about 3.1 mills/kWhr(e) based on a capital charge rate of 12% per year and an 80% load factor. Experimental data on graphite behavior also indicate that graphites with improved dimensional stability under irradiation can be developed, which would lead to improved reactor performance. The deposition of fission products on graphite does not appear to be large (10 to 35% of the noble-metal fission products based on MSRE experience); taking into account graphite replacement every two years, fission product deposition reduces the MSBR breeding ratio by about 0.002. Also, it appears that xenon poisoning can be kept at a 0.5% fraction poisoning level by using pyrolytic carbon as a pore impregnant which seals the surface of MSBR graphite and/or by efficient gas stripping of the fuel salt fluid by injection and removal of helium gas bubbles. It is concluded that good MSBR performance can be obtained by using graphite having combined properties presently demonstrated by small-size samples, and that development of MSBR graphite having such properties is feasible. (auth)

22696 RADIATION DAMAGE OF ORDERED V_6C_5 BY ELECTRON MICROSCOPE BEAM BOMBARDMENT. Venables, John D.;

Lye, R. G. (Martin Marietta Corp., Baltimore). Phil. Mag., 19: 565-82(Mar. 1969).

The superlattice and domain structures exhibited by the ordered compound V_6C_5 are disrupted by electron microscope beam bombardment. The effect is attributed to the disordering of the carbon sublattice that results from displacement of the carbon atoms by the impinging electrons. Studies were made of the disordering rate under electron bombardment at energies from 33 to 100 keV, using a Faraday cup to measure superlattice spot intensities. The results are compared with the predictions of a simple theory for the damage process, from which it is concluded that the displacement energy of carbon atoms in V_6C_5 has the surprisingly low value of 5.4 eV. (auth)(UK)

22697 GAS-RELEASE STUDY OF THE ANNEALING OF BOMBARDMENT-INDUCED DISORDER. I. STUDIES ON BOMBARDMENT-INDUCED DISORDER. Jech, Cestmir (Inst. of Physical Chemistry, Prague); Kelly, Roger. J. Phys. Chem. Solids, 30: 465-74(Mar. 1969).

Many oxides and diamond-type materials become disordered, e.g., amorphous, when bombarded with heavy ions at doses greater than 10^{14} to 10^{16} ions/cm^2. Though the most direct evidence for such disorder is probably electron diffraction, much information can also be gained by studying the motion of the ions used to produce the disorder. In this way the following temperatures for disorder annealing were established (all in °C and for a time scale of 25°C/min): 730° with α-Al_2O_3, 445° with Cr_2O_3, 535° with α-Fe_2O_3, 480° with rutile, 325° with MgO, 285° with NiO, 470° with Ge, and 720° with Si. A significant point is that the ratios of the disorder-annealing temperatures to those for atomic-scale cation self-diffusion are similar for most of the materials studied. The temperature widths of the annealing were also measured, and it was shown that they were, except for MgO and NiO, compatible with single-jump kinetics, namely 45 to 70°C. It is concluded that the annealing process probably involves the growth of crystalline material toward the bombarded surface, such that the bombarding ions are swept out as the disorder-crystal interface reaches the surface. This model is of interest in implying that the activation enthalpies of the annealing, e.g., 52 ± 3 kcal/mole with rutile, are similar to those for self-diffusion in the disordered phase. (auth) (UK)

22698 GROWTH OF FISSION GAS BUBBLES IN IRRADIATED URANIUM DIOXIDE. Cornell, R. M. (Central Electricity Generating Board, Berkeley, Eng.). Phil. Mag., 19: 539-54(Mar. 1969).

The growth of fission gas bubbles from supersaturated solution in irradiated uranium dioxide was studied by electron microscopy under isothermal annealing conditions between 1300 and 1500°C. Measurements of the kinetics of bubble growth enabled the diffusion coefficients of atomic xenon and krypton in irradiated uranium dioxide to be determined. The diffusion coefficients obtained may be expressed by the equation: $D = (2.1 \pm 1.1)10^{-4} \exp [(-91{,}000 \pm 14{,}000/RT)]$. The results obtained from the current experiments are believed to be more precise than most of those obtained using the Booth model for gas released from solid samples of irradiated uranium dioxide during a post-irradiation anneal. (auth)(UK)

22699 EFFECT OF HIGH NEUTRON EXPOSURE ON THE DIMENSIONS OF PYROLYTIC CARBONS. Bokros, J. C.; Dunlap, R. W.; Schwartz, A. S. (Gulf General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167. Carbon, 7: 145-61(Feb. 1969).

Data from several irradiation experiments carried to high neutron exposures show that the irradiation induced densification that is familiar at low exposures is replaced by an expansion process at high exposures. It is suggested that intercrystalline irradiation creep may play an important role in the expansion process. In addition, at high exposures, the shape changes of all the carbons taken as a group depart from the relations predicted by crystalline averaging methods. The nearly isotropic carbons behave as if either the crystallite's shape change rate is enhanced by the accumulated irradiation damage or that the expansion caused by the new porosity generated at high exposures is directed perpendicular to the original deposition plane. The data also show that, for turbostatic carbons with apparent crystallite sized $L_c = 120-200$ Å, an irradiation at ~600°C to $\sim 1 \times 10^{21}$ n/cm^2 does not influence the neutron-induced dimensional changes that occur in a subsequent irradiation at ~900°C. (auth)(UK)

22700 RADIATION-INDUCED DIMENSIONAL CHANGES AND CREEP IN CARBONACEOUS MATERIALS. Bokros, J. C.; Guthrie, G. L.; Dunlap, R. W.; Schwartz, A. S. (Gulf General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167. J. Nucl. Mater., 31: 25-47(May 1969).

At high fast neutron exposures, the dependences of the irradiation-induced dimensional changes on the structure of turbostratic carbons depart from those established at lower exposures. After an initial densification which is first order with respect to the density defect, the densification ceases and the material expands and the rate at which the material changes shape increases. It is thought that the acceleration of the rate of dimensional change is a result of the autocatalytic influence of radiation-generated defects and irradiation-induced increases in anisotropy. The new porosity responsible for the expansion at high doses is thought to be associated with large intercrystalline strains that are relaxed by radiation creep. Measurements of the macroscopic creep strains indicate that strain rates of at least about 2, 3 and 6% per 10^{21} n/cm^2 ($E > 0.18$ MeV) can be accommodated at 600, 900 and 1200°C, respectively, and total strains of about 10% in tension are possible. These measurements, together with the dimensional change behavior of isotropic carbon coatings for nuclear fuel particles, show that for survival to high neutron exposures, the density must be chosen so that coatings will not fail early in life due to densification and so that intolerable anisotropic behavior will not be encountered late in life. The data suggest that, for the designs most commonly used, the optimum densities for isotropic carbons lie in the range 1.5 to 1.8 g/cm^3. Comparison of the data for turbostratic carbons and data for graphitic materials shows that at approximately 1200°C, the dimensional change rate can vary by two orders of magnitude with crystallinity. The influence is considerably less at 600°C. (auth)

22701 NEUTRON EFFECTS IN THERMALLY TREATED GLASSES. Tuohig, W. D.; Hench, L. L. (Univ. of Florida, Gainesville). J. Nucl. Mater., 31: 86-92(May 1969).

Dielectric measurement and small angle x-ray scattering techniques were used to examine the structure of a binary Li_2O-$2SiO_2$ glass after exposure to an integrated flux of 10^{17} nvt fast neutrons. There is little change in the dielectric properties of the as-cast, amorphous glass. However, the results indicate that irradiation accelerates the sequence of crystallization reactions occurring during thermal treatment of the glass. The dissolution rate of lithium metasilicate crystals which appear as a precursor to equilibrium crystallization appears to be enhanced. (auth)

Plastics and Other Materials

Refer also to abstracts 21872, 21928, 22455, 23825, 23849–23856, 23869, 23936, 23937, 24023–24025, and 24029.

22702 (BNL-13493) MODEL FOR THE STRENGTH OF CEMENT-POLYMER AND CONCRETE-POLYMER SYSTEMS. Auskern, Allan (Brookhaven National Lab., Upton, N. Y.). Mar. 1969. 24p. Dep. CFSTI.

Using semi-empirical models for the compressive strength of cement as a function of porosity and filler content a model for the strength of cement-polymer was developed. The strength of cement-polymer can be expressed by the equation $S_c = (120{,}000\ V_m)\ (1 - P)^6$ where S_c is the compressive strength in psi, V_m is the volume fraction matrix (cement), and P is the real porosity of the cement-polymer composite. The model predicts that strengths as high as 40,000 to 50,000 psi are theoretically attainable in this system. The model was extended to the concrete-polymer system. It was necessary, in order to compute the strengths of concrete and concrete-polymer, to assume that in addition to strengthening the cement, the presence of polymer improved the bonding between the cement and aggregate. This had been concluded earlier. Reasonable agreement between predicted and observed concrete-polymer strengths were achieved. (auth)

22703 (N-68-36070) EXPERIMENTAL INVESTIGATION AND ANALYSIS OF DIELECTRIC BREAKDOWNS INDUCED BY ELECTRON IRRADIATION IN POLYMER FILMS. Storti, George M. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Oct. 1968. 35p. (NASA-TN-D-4810). CFSTI.

The phenomenon of dielectric breakdowns caused by electron irradiation was investigated in several polymeric materials. The frequency of occurrence of the breakdowns (as measured by the number of breakdowns occurring for a given fluence of electrons) was dependent on factors such as the electron kinetic energy, electron flux, sample radiation history, and sample temperature. Also, some materials (for example, Teflon) were found to be more susceptible to the dielectric breakdowns than others (for example, polyethylene). These results were interpreted in terms of a modified band model for organic insulators. This modified band model successfully explained many of the experimental observations. Consequently, relative depths of electron traps in some of the materials were surmised from the experimental data. (STAR)

22704 MICROSTRAIN INVESTIGATION OF POLYETHYLENE. Rabinowitz, Stephen. Philadelphia, Univ. of Pennsylvania, 1968. 350p.

Thesis.

The small strain mechanical behavior of linear polyethylene was investigated using an extensometer operating at strain resolutions on the order of 10^{-7}. The nature of the crystalline contribution to the total deformation of the spherulitic polyethylene, and the extent of such crystalline compliance were examined. Observations are discussed in terms of several possible shear mechanisms—slip, twinning, and a stress-induced transformation from orthorhombic to monoclinic crystal symmetry. The influence of such morphological features as molecular folding and crystalline and amorphous phase separation on the various shear processes was examined. Several models for the crystallite deformation are discussed with respect to their applicability to reversible crystal plasticity, and to the observed transition from a thermally activated deformation governed by two frictional stresses at cryogenic temperatures, to a temperature independent deformation characterized by a single frictional stress at room temperature. (Diss. Abstr.)

22705 PREPARATION AND PROPERTIES OF THORIUM PHOSPHIDES. Adachi, Hirohiko; Imoto, Shosuke. Technol. Rep. Osaka Univ., 18: 377-84(Oct. 1968).

Thorium phosphide, Th_3P_4 was prepared by the direct reaction of thorium metal powder and red phosphorus vapor. Successively decomposing Th_3P_4 at 1100°C in vacuum, monophosphide ThP, which was dark blue in color, was obtained. By x-ray diffraction and chemical analysis, thorium monophosphide thus obtained was found to have a NaCl type structure with lattice constant of 5.8332 ± 0.0002 Å and have the composition of $ThP_{0.62}$. The phase study resulted that monophosphide had an existence range of $ThP_{0.4}$ to $ThP_{0.7}$ at 1200°C. The properties of thorium phosphides including magnetic susceptibility, electrical resistivity and hardness was measured. The magnetic susceptibility measurement showed that both of Th_3P_4 and ThP possessed weak and temperature independent paramagnetism. The electrical resistivity of monophosphide had a positive temperature coefficient and the room temperature resistivity decreased with an increase of P/Th ratio. The hardness of monophosphide decreased with an increase of phosphorus content from about 400 kg/mm^2 for the $ThP_{0.4}$ to about 180 kg/mm^2 for $ThP_{0.6}$. (auth)

22706 X-RAY DIFFRACTION STUDIES OF IRRADIATED U_3Si. Hann, C. R. (Battelle Memorial Inst., Richland, Wash.); Leggett, R. D.; Feraday, M. A.; Chalder, G. H. Contract AT(45-1)-1830. J. Nucl. Mater., 31: 114-16(May 1969).

Irradiated sections of U_3Si fuel rods mounted in stainless steel were polished and etched to ensure the removal of any worked metal and were then examined by x-ray diffraction. Results showed no gross effects of irradiation on the crystal structure of the samples. Differences in results from those of previous studies seem to be associated with differences in irradiation conditions or differences in surface preparation. It is possible that the higher temperatures used in this study resulted in reordering due to the annealing process. (F.S.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

22707 INTRODUCTION TO SPACE SCIENCE. SECOND EDITION. REVISED AND ENLARGED. Hess, Wilmot N.; Mead, Gilbert D. (eds.). New York, Gordon and Breach, Science Publishers, 1968. 1072p.

Numerous developments, experimental and theoretical, have necessitated major changes in many of the chapters. Five of them have been completely rewritten and ten of the remaining eighteen have been substantially revised or enlarged. Extensive reviews are given on the Earth's magnetic field, the atmosphere, the ionosphere, the radiation belts, aurorae, meteorology from space, shape of the Earth, the interplanetary medium, boundary of the magnetosphere, cosmic rays, interplanetary dust particles, cosmic chemistry, orbital mechanics, man in space, origin of the solar system, physics of the Sun, the Moon, planetary atmospheres, planetary structure, space astronomy, stellar evolution, extragalactic radio sources, and nucleosynthesis. (W.D.M.)

Cosmic Ray Exposure Ages

22708 ISOTOPIC COMPOSITION OF SULFUR AND SULFATE PRODUCED BY OXIDATION OF FeS. Lewis, John S. (Massachusetts Inst. of Tech., Cambridge); Krouse, H. Roy. Earth Planet. Sci. Lett., 5: 425-8(Feb. 1969).

Sulfate enriched in ^{32}S with respect to coexistent sulfur is found in the Orgeuil meteorite. Similar isotopic distributions can be effected with at least three laboratory procedures: (1) oxidation of FeS by traces of a strong oxidizing agent such as O_2 or HOOH in a generally reducing aqueous environment, (2) bacterial oxidation of sulfides, or (3) reaction of elemental sulfur with water followed by partial oxidation of the unequilibrated products. For many reasons, the first mechanism is attractive for explaining the $^{32}S/^{34}S$ distribution in the carbonaceous chondrites. (auth)

22709 THE COMPOSITION OF STONY METEORITES. III. SOME INTER-ELEMENT RELATIONSHIPS. Ahrens, L. H.; Von Michaelis, H. (Univ. of Cape Town). Earth Planet. Sci. Lett., 5: 395-400(Feb. 1969).

The relationship between Ca and Al in chondrites and basaltic achondrites was examined and is shown to be remarkably close. According to the data, Ti, Zr, and Sr show a like relationship, which however, may not be so well-developed. The available data in the literature show that Sc, Y, rare earths, Ba, U, and Th have similar trends. All the above elements were classed as the Ca–Al group. Their behavior is important when considering theories of origin of the meteorites and of other members of the solar system. (auth)

22710 THE COMPOSITION OF STONY METEORITES. II. THE ANALYTICAL DATA AND AN ASSESSMENT OF THEIR QUALITY. Von Michaelis, H.; Ahrens, L. H.; Willis, J. P. (Univ. of Cape Town). Earth Planet. Sci. Lett., 5: 387-94 (Feb. 1969).

Quantitative data for Fe, Si, Mg, Al, Ca, Mn, Ti, K, P, Zr, Sr and Rb in 48 chondrites and 6 achondrites are presented. Five of the chondrites and one achondrite have not been analyzed before. The quality (precision and accuracy) of the data are critically assessed. (auth)

22711 THE COMPOSITION OF STONY METEORITES. I. ANALYTICAL TECHNIQUES. Von Michaelis, H.; Willis, J. P.; Erlank, A. J.; Ahrens, L. H. (Univ. of Cape Town). Earth Planet. Sci. Lett., 5: 383-6(Feb. 1969).

Details are given of the preparation of stony meteorite samples and of the x-ray fluorescence methods used for determining Fe, Si, Mg, Ca, Al, Ti, Mn, K, P, Zr, Sr and Rb in the samples. (auth)

22712 INITIAL STRONTIUM ISOTOPIC ABUNDANCES AND THE RESOLUTION OF SMALL TIME DIFFERENCES IN THE FORMATION OF PLANETARY OBJECTS. Papanastassiou, D. A.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett., 5: 361-76(Feb. 1969).

It is shown that differences in the $^{87}Sr/^{86}Sr$ ratio corresponding to about 10^{-2}% are clearly resolvable using improved instrumental techniques. Several basaltic achondrites having a total spread of 0.2% in $^{87}Sr/^{86}Sr$ were studied and appear to define an identical initial $^{87}Sr/^{86}Sr$ abundance corresponding to 0.698976 ± 0.000055 (maximum uncertainties). These samples are found to lie on a well defined isochron with a slope of 0.0629 ∓ 0.0037 and an age $4.39 \mp 0.26 \times 10^9$ yr, for $\lambda = 1.39 \times 10^{-11}$ yr^{-1}. The maximum deviation of a data point from the best fit line is 6×10^{-3}%. This shows that if the samples were derived from material with chondritic or solar Rb/Sr abundance ratios, they were formed within a time period of 4 m.y. or 1.6 m.y., respectively. The application of such measurements to establish a refined early solar system chronology is discussed. (auth)

Stars

Refer also to abstract 22938.

22713 (N-68-36362) PROBLEMS OF INTENSE MAGNETIC FIELD IN GRAVITATIONAL COLLAPSE. Chiu, Hong-yee; Canuto, Vittorio (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies). [1968]. 16p. (NASA-TM-X-61285). CFSTI.

During gravitational collapse, magnetic fields of the order of 10^{14} gauss can be achieved. The quantum theory of an electron gas in such a field was developed and the major results are reported. The equation of state, the spontaneous magnetization, and the spontaneous pair creation are discussed. It is shown that spontaneous pair creation can be achieved only when the anomalous magnetic moment of the electron is included in the Dirac equation. The number of created pairs is explicitly given. (auth) (STAR)

22714 (N-68-37682) CORONAE AROUND HELIUM STARS AND X-RAY SOURCES. Nariai, Kyoji (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Sept. 1968. 6p. (NASA-TM-X-63364; X-641-68-360). CFSTI.

Calculations of the acoustic energy generation for helium-rich composition show that the maximum acoustic energy generation is located around 12,000°K at log g = 4 and 15,000°K at log g = 6. X rays from a corona around a helium star are strongest when the physical parameters of the star are log g ≈ 6 and Te ≈ 15,000°K. But the total energy flux is too small to account for the observed x-ray sources. (auth) (STAR)

22715 ELECTRON GAS IN INTENSE MAGNETIC FIELDS. Chow, T. L. (Univ. of Rochester, N. Y.). Astrophys. Lett., 3: 85-6(Mar. 1969).

Behavior of electrons in the nondegenerate envelope of a magnetic white dwarf is discussed, and a distribution law is found. The possibility of increased opacity due to the presence of the magnetic field is then pointed out. (auth)

22716 SHORT-PERIOD VARIABILITY OF B, A, AND F STARS. V. THE COMA CLUSTER AND NGC 752. Breger, M. (Univ. of California, Berkeley). Astrophys. Lett., 3: 67-71 (Mar. 1969).

Details of a photoelectric search for δ Scuti variables in the Coma cluster and the old galactic cluster NGC 752 are given. Only one variable was found in the Coma cluster, while no δ Scuti variables were found in NGC 752. This result is in agreement with the expected variability as a function of absolute magnitude and color determined from the field stars. The possibility that the ultrashort-period variations found by other observers in 21 Com, as well as in at least three other peculiar A stars, can be identified with pulsations similar to those found in δ Scuti stars is discussed briefly. (auth)

22717 HOMOGENEOUS MAIN SEQUENCE MODELS WITH CONVECTIVE CORES. II. Bennick, Alfred (Hunter Coll., Bronx, N. Y.); Motz, Lloyd; Linsker, Ralph. Trans. N. Y. Acad. Sci., 30: 815-32(Apr. 1968).

A procedure has been developed for integrating families of stellar models with convective cores in which the chemical composition, core size, and ratio δ of the energy generated in the core by the carbon cycle to that generated in the core by the proton–proton (p–p) chain are the adjustable parameters. This method of constructing stellar models allows determination of the range of the main sequence over which convective core stars exist and derivation of the zero main sequence itself from the integrated models. In this procedure the global properties of the star, that is, its mass, radius, and luminosity, are determined by the integration so that, in principle at least, the entire star's structure is determined once its chemical composition and its core size have been fixed. One choice of the parameter δ will lead to a physically realizable model. What limitations are on the variation of δ are considered. The results show that for a given chemical composition and core size the parameter δ is bounded both from above and below and the value corresponding to a main sequence model lies within this range. It was shown that there is a critical core size for a given chemical composition below which no model can be constructed. The described method of constructing these stellar models gives insight into the relation between the core size and ratio of the carbon–nitrogen (CN) cycle to the p–p chain in the core, and permits determination of the dependence of core size on the energy-generation law with great accuracy. (BBB)

22718 INFRARED SURVEYS OF THE SOUTHERN MILKY WAY. I. SUSPECTED SUPERGIANT STARS. Albers, Henry (Vassar Coll. Observatory, Poughkeepsie, N. Y.). Astrophys. J., 156: L37-40(Apr. 1969).

An infrared objective-prism survey was carried out along the southern Milky Way for the purpose of identifying stars that show the high-luminosity triplet of O I at 7774 Å. A list of seventy-six such stars is given. (auth)

22719 SPECTROPHOTOMETRY AND INFRARED PHOTOMETRY OF BL LACERTAE. Oke, J. B. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Neugebauer, G.; Becklin, E. E. Astrophys. J., 156: L41-3(Apr. 1969).

The absolute spectral-energy distribution of BL Lacertae from 0.315 to 2.2 μ indicates that the optical radiation might be a continuation of the observed radio-synchrotron flux. The very steep slope of the spectral-energy distribution suggests that the object is not a quasi-stellar radio source. Only one very faint spectral feature may exist, and no redshift can be derived. (auth)

22720 INFRARED OBSERVATIONS OF ETA CARINAE TO 20 MICRONS. Westphal, J. A.; Neugebauer, G. (California Inst. of Tech., Pasadena). Astrophys. J., 156: L45-8(Apr. 1969).

Measurements of η Carinae were obtained at 4.8, 10.1, and 19.5 μ which show a continued increase in flux density into the infrared. The bolometric magnitude is estimated to be -12. (auth)

22721 PLANETARY NEBULAE. International Astronomical Union Symposium No. 34, held in Tatranska Lomnica, Czechoslovakia, 4-8 September 1967. Osterbrock, D. E.; O'Dell, C. R. (eds.). New York, Springer-Verlag New York Inc., 1968. 482p. $24.00. (CONF-670979).

The symposium was devoted to all phases of research on planetary nebulae and their central stars. Sections headed by an introductory review article, summarizing the present state of knowledge and the unsolved problems in that particular field, treat the basic data, observations in all spectral regions, physical processes, structure and dynamics of the nebulae, spectra and atmospheres of the central stars, the origin of planetary nebulae, and the internal structure and evolution of their stars. (W.D.M.)

22722 POLARIZATION OF THE CONTINUUM BACKGROUND IN PLANETARY NEBULAE. Leibowitz, Elia M. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 156: 261-7 (Apr. 1969).

An expression is derived for the expected polarization of the continuum background of planetary nebulae in a given "window" in the visible spectrum. The polarization discussed results from electron scattering of the radiation of the nucleus star by the electron gas in the nebula. It is found that in one nebula the effect should be measurable. (auth)

22723 EXTERIOR SOLUTION FOR RADIATING SPHERES WITH ZERO LIMB DARKENING IN GENERAL RELATIVITY. Kaufmann III, William J. (Univ. of California, Los Angeles). Astrophys. J., 156: 257-60(Apr. 1969).

Zero limb darkening is defined as the case where a freely falling observer sees a uniformly illuminated disk, and the field equations in Bondi's radiation coordinates are presented. By expanding the nonvanishing components of the metric tensor in powers of $1/r$ a solution to these field equations is obtained; the first seven terms are worked out explicitly. In particular it is found that the entire solution is generated by the asymptotic solution. The asymptotic solution, characterized by two functions of the timelike coordinate, is the solution which holds when $\cos Z \approx 1 - \frac{1}{2}Z^2$, where Z is one-half of the angular diameter of the observed stellar disk. The complete solution requires all the higher-order derivatives of these two functions. Thus all the parameters of the radiation field, such as the radiative flux and the radiation pressures, are determined once the solution at large distances for the star is specified. (auth)

22724 CRITERION FOR NUCLEAR-ENERGIZED PULSATIONAL INSTABILITY. Simon, Norman R.; Stothers, Richard (Goddard Inst. for Space Studies, New York). Astrophys. J., 156: 377-80(Apr. 1969).

This note presents briefly some general properties of nuclear-energized pulsations of stars as treated in linear quasi-adiabatic theory. In particular, the results are derived from a number of detailed calculations of stellar models. (W.D.M.)

22725 CHROMOSPHERES AND POLARIZATION IN LATE-TYPE STARS. Dyck, H. Melvin; Johnson, Hollis R. (Indiana Univ., Bloomington). Astrophys. J., 156: 389-92(Apr. 1969).

Polarization measurements and emission core intensities of the Ca II K-line are compared for the ten stars for which such observations are available. In spite of the scarcity of data, a relationship between the observed variation of polarization and the intensity of the Ca II K2 peak is found, in the sense that stars with stronger K2 peaks show smaller changes in polarization. This is in accord with the association of Ca II emission cores with stellar chromospheric heating and polarization with the presence of molecules or particles in a cool outer atmosphere. (auth)

22726 EFFECT OF LINE ABSORPTION ON MAIN-SEQUENCE MODEL STARS. Cesarsky, Catherine J. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 156: 385-8(Apr. 1969).

The inclusion of line-absorption effects in the opacity, in the construction of homogeneous stellar models, has three main consequences: the luminosity is lowered, the radius is increased, and the convective core comprises a smaller fraction of the mass of the star. The zero-age main sequence is slightly shifted to the right. (auth)

22727 OPTICAL BACKSCATTERING FUNCTIONS IN THE PLEIADES. O'Dell, C. R. (Yerkes Observatory, Williams Bay, Wis. Univ. of Chicago. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 156: 381-4(Apr. 1969).

Optical wavelength backscattering (radar) functions are derived for two nebulae in the Pleiades Cluster. It is seen that the radar functions for the three nebulae studied to date do not agree with any of the widely discussed models for interstellar particles. (auth)

22728 THE DISTANCE OF THE HYADES AND THE MASS–LUMINOSITY RELATION. Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J., 156: 241-56(Apr. 1969).

Evidence supporting a difference in the mass–luminosity relation for Hyades stars relative to stars of the Sun–Sirius type is reviewed. Objections raised by Hodge and Wallerstein, Alexander, and Demarque concerning the Hyades distance and the orbital elements are examined and shown to be contrary to present evidence. The moving-cluster distances of individual stars by Wayman, Symms, and Blackwell are supported by the agreement between the observed (M_V, R–I) relation for the Hyades main sequence and red dwarfs in the field with trigonometric $\pi \geq 0''.125$, in disagreement with the challenge of Hodge and Wallerstein. The need to examine the basic binary-star data and to adopt standard observers is once again illustrated by examples. Failure to assess critically the data would lead to spurious results. Alexander's contention that corrections cannot be objectively made is shown to be incorrect. Results for given stars obtained with a visual micrometer, when compared with data from interferometer measurements and from photographic plates for the same stars obtained during epochs of wide separation, show that data from the standard observers define a true and uniform scale to within 1 or 2%, while data obtained by observers using smaller instruments do not. First-class data exist for only three binaries in the Hyades Cluster. Systems which cannot be used are ADS 3169, which is a spectroscopic binary of period ~4 days, ADS 3248, which has a variable radial velocity, ADS 3483, which shows a systematic perturbation in separation with a period of a few years, and four other stars for reasons given in the text. Masses from the three first-class binaries define a different M–L relation than that for stars of the Sun–Sirius type. To remove the difference would require errors in the proper motions an order of magnitude larger than those derived for the two highest weight systems. Furthermore, the resulting parallax would place these stars more than 0.5 mag from the mean (M_V, B–V) relation for other Hyades stars. The binary 10 UMa in the extended Hyades group, together with other field binaries which have no ultraviolet excess relative to the Hyades, show the same M–L difference. (auth)

22729 A MATRIX METHOD FOR CALCULATING THE SOURCE FUNCTION, MEAN INTENSITY, AND FLUX IN A MODEL ATMOSPHERE. Kurucz, Robert L. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 156: 235-40(Apr. 1969).

The integrals for the mean intensity and flux are expressed as the multiplication of the source-function vector by matrix representations of the integral operators. This method leads to a rapid solution of the integral equation for the source function and to an efficient calculation of the mean intensity and flux. (auth)

22730 THE STRUCTURE OF WHITE-DWARF ATMOSPHERES. III. THE ATMOSPHERE OF 40 ERIDANI B. Matsushima, Satoshi; Terashita, Yoichi (Pennsylvania State Univ., University Park). Astrophys. J., 156: 219-34(Apr. 1969).

The surface parameters of 40 Eri B are determined from comparisons of various observations with theoretical predictions based on a grid of line-blanketed and flux-constant model atmospheres. Special attention is directed to the problem of determining the hydrogen abundance, as well as the effective temperature and the surface gravity. The observational data used in the analysis consist of the UBV and six-color photometries, photoelectric scanner observations of monochromatic flux, and the profiles of hydrogen lines. The final model which predicts the best agreement with the above set of observations as well as the observed mass (0.43 ± 0.04 $M_\odot$) has a value of 0.900 for the hydrogen content, 15,300° ± 380°K for the effective temperature, and 7.720 ± 0.098 for the logarithmic surface gravity. The adopted model predicts a radius of 0.0150 ± 0.0003 $R_\odot$ and a gravitational redshift of 18.2 ± 4.9 km sec^{-1} as compared with the observed value of 21 ± 4 km sec^{-1}. The resultant mass and radius appear to be consistent with the theoretical mass-radius relation for a zero-temperature degenerate star. (auth)

22731 THE STRUCTURE OF WHITE-DWARF ATMOSPHERES. II. MASSES AND RADII DETERMINED FROM ATMOSPHERIC PARAMETERS OF DA STARS. Terashita, Yoichi; Matsushima, Satoshi (Pennsylvania State Univ., University Park). Astrophys. J., 156: 203-18(Apr. 1969).

A grid of model atmospheres for DA stars was constructed by taking into account the blanketing effect of Balmer and Lyman lines, and effective temperatures and surface gravities were determined by comparing the observed color indices with those predicted by the models. The effect of line blanketing on the temperature stratification is such that the (U−B, B−V)-diagram predicts effective temperatures which are about 10% lower than the values obtained from models without blanketing, while no significant change is found in the surface gravities. Instead, a careful treatment of Balmer-line blocking for the computation of the emergent flux, using a more accurate Stark profile, leads to an increase of about 0.7 in log g. The masses and radii determined for thirty DA stars for which the luminosities are known are compared with the theoretical mass−radius relations for zero-temperature degenerate stars composed of heavy elements, and possible causes of the large discrepancies shown by the stars are discussed. (auth)

22732 RADIATIVE OPACITY IN STELLAR ATMOSPHERES. III. EFFECT OF THE HYDROGEN-TO-HELIUM RATIO ON THE ATMOSPHERIC STRUCTURE. Matsushima, Satoshi; Terashita, Yoichi (Pennsylvania State Univ., University Park). Astrophys. J., 156: 183-202(Apr. 1969).

A grid of line-blanketed model atmospheres with different hydrogen-to-helium ratios is constructed for wide ranges of T_{eff} and log g in order to investigate the effect of differing hydrogen content on the structure of stellar atmospheres. The changes in the emergent flux distribution with wavelength, UBV color indices, and the Hγ and Hδ profiles are also considered. It is found that a small reduction in the H-to-He ratio produces a large increase in the electron pressure as well as in the gas pressure, and that the change in P_e produces considerable effects on the observable features. On the other hand, the effect of hydrogen content on the temperature stratification is small until the H-to-He ratio is reduced to about 0.1. Theoretical interpretations are presented to account for the variations in T, P_e, and P with varying hydrogen content in terms of differential variations in the relative importance of H, H^-, and He as sources of atmospheric opacity coupled with Lyman- and Balmer-line blanketing. Since an increase in P_e also results from an increased surface gravity, the variations of the observable quantities with hydrogen content or with surface gravity are generally indistinguishable. A general formula is derived to relate the errors due to uncertainties in log g and those in hydrogen content. In a hydrogen-rich atmosphere, the accuracies in the determinations of the surface gravity and hydrogen content from the color indices are estimated to be ~0.1 in log g and about 15% in the hydrogen content for a model with $T_{eff} \sim 15{,}000$°K and log g ~ 7. Since a small change in hydrogen content has little effect on T_{eff}, the determination of T_{eff} from observed color indices appears to be a promising method for white dwarfs. For stars with lower g, however, the use of hydrogen line profiles may be superior to the use of color indices in determining the atmospheric parameters, although in this case it is not possible to determine T_{eff} independently from g and the H-to-He ratio. (auth)

22733 MODEL ATMOSPHERES FOR RR LYRAE STARS. Strom, S. E. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 156: 177-82(Apr. 1969).

Model atmospheres were computed in the range $6000° \leq T_{eff} \leq 7500$°K with $2.0 \leq \log g \leq 3.5$. These parameters are representative of those that obtain for stars in the RR Lyrae gap. Convection is found to play a significant role in the influence of the emergent fluxes predicted by these models. Temperature determinations based on purely radiative models are systematically too low by as much as 200° to 350°K; gravity determinations are not affected. The method of predicting B−V, and thus reddening, from the strength of the Balmer lines is found to give less than desirable results. The influence of line blanketing and departures from LTE on these models is also discussed. (auth)

22734 NON-LTE MODEL ATMOSPHERES. I. RADIATIVE EQUILIBRIUM MODELS WITH LYMAN-ALPHA. Auer, L. H.; Mihalas, Dimitri (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. J., 156: 157-75(Apr. 1969).

Models are presented of stellar atmospheres of pure hydrogen in hydrostatic, radiative, and statistical equilibrium, including for the first time Lyman-α as well as continua. Only by the direct inclusion of Ly-α may one properly evaluate the effect of this strong line on the structure of the atmosphere. A new temperature-correction scheme was used. It is of the constraint type, is capable of handling very large opacity variations, and guarantees vanishingly small flux derivatives. This model atom assumed the upper fourteen levels in LTE, but permitted non-LTE deviations in the lower two levels. This model was sufficient to show that: (a) non-LTE effects from the continua cause a temperature rise at the surface; (b) this rise is partially offset by the inclusion of Ly-α, which causes a temperature drop, the non-LTE drop being very much smaller than the LTE; (c) Ly-α is so optically thick that it does not affect the formation of even the Lyman continuum; and (d) there is essentially no back-warming due to Ly-α in either the LTE case or the non-LTE case. (auth)

22735 MODELS FOR THE ENVELOPES OF Be STARS. Marlborough, J. M. (Yerkes Observatory, Williams Bay, Wis.). Astrophys. J., 156: 135-55(Apr. 1969).

The excitation and ionization states for hydrogen atoms assumed to have five bound levels are determined by means of a convenient method of approximation at different points within several model envelopes whose physical and geometrical properties have been derived from what appear to be reasonable assumptions for the envelopes of Be and shell stars. The method employed appears to provide sufficient accuracy, and the resulting Hα line profiles are in good agreement with the observations. The dependence of the line profile on the density in the envelope is demonstrated for four densities ranging from 5×10^9 to 5×10^{12} cm^{-3} at a point in the equatorial plane 3 stellar radii above the star's surface. The models for densities 5×10^{11} and 5×10^{12} cm^{-3} seem best to represent typical Be stars. Profiles are computed for models based on three choices for the dependence with distance of that component of the envelope's velocity which is directed away from the star's rotation axis. The effective emitting and absorbing regions of the envelopes are shown to extend in the equatorial plane to at least 10 stellar radii above the photosphere. Thermal support perpendicular to the equatorial plane appropriate to an electron temperature of 10^4°K appears sufficient when taken together with the extent in the equatorial plane of the extensive emitting and absorbing regions to produce the deep shell lines which are observed. For the steady-state envelopes considered here, the rates of mass loss lie in the range $10^{-6}$to 10^{-7} $M_\odot$ per year. (auth)

22736 FURTHER PHOTOMETRY OF EX HYDRAE. Mumford, George S. (Tufts Univ., Medford Mass. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 156: 125-33(Apr. 1969).

Recent observations indicate that there has been no significant change in the orbital period of this system, though the minima appear more variable in shape than noted previously. (auth)

22737 PHOTOELECTRIC SCANNER OBSERVATIONS OF CH CYGNI FOR AUGUST 3, 1967. Walker, G. A. H.; Morris, S. C.; Younger, P. F. (Dept. of Energy, Mines, and Resources, Victoria, B. C.). Astrophys. J., 156: 117-23(Apr. 1969).

Twelve scans of the CH Cygni spectrum (taken after the report of a variable violet continuum) from 3300 to 5000 Å were calibrated in relative flux units by comparison with Oke's standards; for comparison, 45 Arietis, which has a similar spectrum to the preoutburst, M-type, CH Cygni spectrum, was also observed and calibrated. High-dispersion spectra taken on the same night are also shown, and graphs of the variations of the excess blue and ultraviolet continua and a table of integrated Hβ emission measures are presented. Most of the excess radiation can be explained in terms of Balmer continuum and line emission, but there is a weaker continuum at other wavelengths increasing in intensity toward short wavelengths which appears when the Balmer continuum brightens. These results are very similar to those reported for the short-lived flares associated with certain dMe stars and suggest that CH Cygni may be detectable at radio wavelengths during an outburst. (auth)

22738 HIGH-DISPERSION CLASSIFICATION OF K2–M6 GIANTS OF HIGH AND LOW VELOCITY. Deutsch, A. J. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Wilson, O. C.; Keenan, P. C. Astrophys. J., 156: 107-15(Apr. 1969).

The classification of early M-type giants by the usual criteria of TiO band strengths was tested by estimating ratios of weak atomic lines on coudé spectrograms of scale 9 to 10 Å mm^{-1}. No systematic differences are found between the types given by the two methods for Population I stars and for high-velocity stars of intermediate Population II. Published V–I and U–I colors also give sequences in agreement with the spectral types. Although there is thus no evidence that TiO bands differ in strength between giants of the two populations studied, in several of the M stars of high velocity a slight weakening of the stronger atomic lines appears to be present. In several stars representing both populations, the absorption lines at Hγ and Hδ show intensity changes on a time scale of weeks or months; but other absorption lines and bands appear not to vary. (auth)

22739 COLLAPSE OF INTERSTELLAR GAS CLOUDS AND THE FORMATION OF STARS. Hunter, James H. Jr. (Yale Univ., New Haven). Mon. Notic. Roy. Astron. Soc., 142: 473-98(1969).

Theoretical models are constructed corresponding to initial phases in the thermal–gravitational collapse of spherical clouds out of the interstellar gas. It is demonstrated that (a) the thermodynamics of interstellar matter are probably the most important single factor influencing the early stages of star formation, and (b) self-gravitating primary condensations of upper main-sequence stellar mass can form out of the medium directly, without the occurrence of fragmentation. (auth) (UK)

22740 THE SPECTRUM OF HR 3817. Jaschek, Mercedes; Aguilar, Maria L. (Observatorio Astronomico, La Plata). Publ. Astron. Soc. Pac., 81: 170-1(Apr. 1969).

HR 3817 was observed at the Bosque Alegre Station of the Córdoba Observatory during a program of study of abnormal B-type stars. Two plates of it were taken on Feb. 17, 1965 with the grating spectrograph. The spectrum was abnormal and its appearance is summarized. (W.D.M.)

22741 UBV OBSERVATIONS OF P CYGNI. Fernie, J. D. (Univ. of Toronto). Publ. Astron. Soc. Pac., 81: 168-9(Apr. 1969).

UBV observations of P Cygni are presented. No short-period variability is discernible, and there appear to have been no secular changes in brightness exceeding a few thousandths of a magnitude over the last six years. (auth)

22742 THERMAL EMISSION BY GRAINS AND THE FREE–FREE EMISSION FROM PLANETARY NEBULAE. Krishna Swamy, K. S. (Goddard Space Flight Center, Greenbelt, Md.). Publ. Astron. Soc. Pac., 81: 154-67(Apr. 1969).

The expected thermal emission for each of 49 planetary nebulae was calculated on the basis of a graphite grain model. The free–free emission from each of these planetaries was also calculated. The results of the present calculations show that the infrared emission from grains of several planetary nebulae should be detectable. The present study should be of considerable help to observers who are interested in the measurement of these infrared fluxes. More observations of the type done for NGC 7027 are badly needed for other planetaries as they will be of considerable help in knowing not only more about the grains but also about their effect on the planetaries themselves. (auth)

22743 THE INTRINSIC COLOR INDICES OF THE RR LYRAE STARS AND THE REDDENING NEAR THE GALACTIC POLES. McNamara, D. H.; Langford, W. R. (Brigham Young Univ., Provo, Utah). Publ. Astron. Soc. Pac., 81: 141-53(Apr. 1969).

Photoelectric observations of stars in the vicinity of RR Lyrae indicate that RR Lyrae is reddened at most by 0.03m in (B–V). UBV observations of RR Lyrae stars are employed to define a line-blanketed color index at minimum light, (B–V)m. By selecting stars at both low and high galactic latitudes in regions apparently free of dark and bright nebulae a color excess E(B–V) ≤ 0.01m is found near the galactic poles. UBV observations of RR Lyrae stars in four globular star clusters are employed to estimate the reddening of the clusters. The color excesses of the clusters found from the RR Lyrae stars are smaller than color excesses determined recently by other methods. (auth)

22744 UBV OBSERVATIONS OF LONG-PERIOD VARIABLE STARS. VI. Landolt, Arlo U. (Louisiana State Univ. Observatory, Baton Rouge. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 81: 134-40(Apr. 1969).

Photoelectric observations of 57 long-period variable stars are presented on the UBV photometric system. (auth)

22745 LIMB-DARKENING TABLES FOR 5040°K ≤ T_{eff} ≤ 7200°K. Margrave, Thomas E. Jr. (Georgetown Coll. Observatory, Washington, D. C.). Publ. Astron. Soc. Pac., 81: 116-20 (Apr. 1969).

A set of limb-darkening tables for subdwarf and dwarf stars with effective temperatures in the range 5040°K ≤ T_{eff} ≤ 7200°K is presented. The wavelength coverage extends from 3646 to 6500 Å. (auth)

22746 IDENTIFICATION LIST OF SPECTROSCOPIC AND ECLIPSING BINARIES SUBJECT TO OCCULTATIONS BY THE MOON. Herr, Richard B. (Mount Cuba Astronomical Observatory, Wilmington, Del. Univ. of Delaware, Newark). Publ. Astron. Soc. Pac., 81: 105-15(Apr. 1969).

Spectroscopic and/or eclipsing binaries in the zodiac are identified for observers who wish to attempt to photometrically resolve such systems through analysis of the diffraction patterns produced when they are occulted by the Moon. (auth)

22747 THE DETECTION AND SURFACE GRAVITIES OF METALLIC-LINE EARLY A STARS. Olson, Edward C. (Univ. of Illinois, Urbana). Publ. Astron. Soc. Pac., 81: 97-104(Apr. 1969).

Spectral classification using equivalent widths of various metallic lines reveals metallicism among early A stars. Most of the Am stars are known close binaries whose surface gravities, obtained from eclipsing binary solutions or from hydrogen line profiles, are near log g = 4.05. (auth)

22748 NEW METHOD OF IDENTIFICATION OF STARS ON ASTRONOMICAL PLATES. Debehogne, H. Bull. Soc. Roy. Sci. Liege, 37: 560-1(1968). (In French).

A new method for the identification of stars on astronomical plates is based on the preliminary calculation of approximate constants on previous plates. If the computer memory has available the right ascension and declination of the stars with magnitude below or equal to 9.2 and the plate constants, the method is the most rapid identification procedure even if the number of stars is less than five. (J.S.R.)

Quasi-Stellar, Radio, and X-Ray Sources

22749 THE PLANETARY NEBULAE NGC 7027 AND IC 418 AT λ 9.5 mm. Terzian, Yervant (Cornell Univ., Ithaca, N. Y.). Astrophys. Lett., 3: 87-90(Mar. 1969).

Radio observations of the planetary nebulae IC 418 and NGC 7027 at λ 9.5 mm are reported. The radio spectra of these nebulae have a definitely thermal character. The physical parameters of the nebulae, such as electron temperature and electron density, are also discussed. (auth)

22750 PHOTOELECTRIC SPECTROPHOTOMETRY OF THE CRAB PULSATING RADIO SOURCE NP 0532. Oke, J. B. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 156: L49-53(Apr. 1969).

The average absolute spectral-energy distributions of the main pulse and the interpulse in the Crab pulsating radio source are similar and are not very different from that of the extended synchrotron radiation from the Crab Nebula. In the visual region the spectrum is not far from being flat if reddening corresponding to a visual absorption of 1.7 mag is assumed. An excellent fit to the visual energy distribution is obtained with a Planck function at a temperature of 10,000°K. Observations made on different nights indicate average brightness differences up to 0.5 mag. Upper limits are placed on the intensities in the pulses of the (O II) and (O III) emission lines. (auth)

22751 ON X-RAY LINE EMISSION FROM SCORPIUS XR-1. Fritz, G.; Meekins, J. F.; Henry, R. C.; Friedman, H. (Naval Research Lab., Washington, D. C.). Astrophys. J., 156: L33-6 (Apr. 1969).

A high-sensitivity measurement of Scorpius XR-1 made with a proportional counter gave no positive indication of line emission near 7 keV. It is shown that the energy in the iron line emission must be less than 5% of that in the continuum between 1.5 and 6 keV. This limit rejects a theoretical thermal-plasma model derived for a low-mass supernova but does not exclude models derived for normal cosmic abundance or a high-mass supernova. (auth)

22752 DETECTION OF THE $^2\Pi_{3/2}$, J = $5/2$ STATE OF OH AT 5-CENTIMETER WAVELENGTH. Yen, J. L. (Univ. of Toronto); Zuckerman, B.; Palmer, Patrick; Penfield, H. Astrophys. J., 156: L27-32(Apr. 1969).

Lambda-doublet radiation from the $^2\Pi_{3/2}$, J = $5/2$ state of interstellar OH was detected with the 150-foot telescope of the Algonquin Radio Observatory. The F = 3 → 3 and F = 2 → 2 transitions were observed in the direction of the anomalous 18-cm emission source in W3. The lines appear to be circularly polarized. (auth)

22753 STATISTICAL TESTS FOR THE ORIGIN OF ABSORPTION LINES OBSERVED IN QUASI-STELLAR SOURCES. Bahcall, John N.; Peebles, P. J. E. (California Inst. of Tech., Pasadena). Astrophys. J., 156: L7-10(Apr. 1969).

Two statistical tests are described for the hypothesis that the multiple absorption red shifts observed in the spectra of at least some quasi-stellar sources arise in intervening material that is randomly distributed in patches along the line of sight to the quasi-stellar sources. (auth)

22754 POSITIONS OF TWENTY-ONE QUASI-STELLAR OBJECTS. Lue, Phillip K. (Yale Univ. Observatory, New Haven). Astrophys. J., 156: L11-14(Apr. 1969).

Accurate positions were determined for twenty-one quasi-stellar objects, which form the first set of objects for a proposed catalogue of optical positions. A tentative identification is given for OA 33. (auth)

22755 OBSERVATIONS OF VARIABLE RADIO SOURCES AT 9.55-MILLIMETER WAVELENGTH. Hobbs, R. W.; Corbett, H. H.; Santini, N. J. (Naval Research Lab., Washington, D. C.). Astrophys. J., 156: L15-18(Apr. 1969).

Periodic observations of 3C 84, 3C 273, 3C 279, and 3C 454.3 were made at 9.55-mm wavelength from the middle of 1966 to the beginning of 1968. Variations of the flux density indicate that for 3C 84, 3C 273, and 3C 454.3 repeated injections of electrons into the source region take place, followed by an expansion of the electron cloud. (auth)

22756 ON THE ABSORPTION SPECTRUM OF TON 1530. Bahcall, John N. (California Inst. of Tech., Pasadena); Osmer, Patrick S.; Schmidt, Maarten. Astrophys. J., 156: L1-5(Apr. 1969).

An analysis of the absorption-line spectrum of Ton 1530 is reported. The line widths are less than 4 Å in the observed frame. Three acceptable absorption red shifts, $z = 1.9365$, $z = 1.9215$, and $z = 1.8866$, and one plausible absorption red shift, $z = 1.9800$, are identified. Only 0.1 acceptable red shift was found per random-number spectrum constructed to have the same essential characteristics as the observed spectrum. (auth)

22757 PECULIARITY IN CRAB NEBULA RADIO EMISSION SPECTRUM IN DECIMETER WAVE RANGE. Alekseev, V. A.; Gatelyuk, E. D.; Dmitrenko, D. A.; Romanychev, A. A.; Tseitlin, N. M. (Gorky Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 168-72(1969). (In Russian).

The results of the second absolute intensity measurements of the Crab Nebula at the wavelengths 30.2, 34.5, 39, 42, 44.1, 57.8, and 57.9 cm are presented. The data obtained point out the presence of a step with the spectral index $\alpha \simeq 0$ in Taurus-A radio-emission spectrum. These data agree with intensity measurements of Crab Nebula radio emission obtained by one of the authors in 1962 at the wavelengths 25.1, 34.25, 35.9, 42.4, and 54.4 cm. (auth)

22758 GALACTIC H II REGIONS. IV. 1.95-CM OBSERVATIONS WITH HIGH ANGULAR RESOLUTION AND HIGH POSITIONAL ACCURACY. Schraml, J.; Mezger, P. G. (National Radio Astronomy Observatory, Charlottesville, Va.). Astrophys. J., 156: 269-301(Apr. 1969).

Compact H II regions of high electron density but small linear dimensions are believed to be the ionized remnants of recently formed O stars or clusters of O stars. In this survey, H II regions of high surface brightness in the radio continuum are mapped at the wavelength of 1.95 cm with an angular resolution of about 2′. Compact H II regions are found to be superimposed on an extended background of lower surface brightness. After separation from the background, the physical parameters of the compact components are determined. Their electron temperatures, rms velocities of internal turbulence, and kinematic distances are obtained from observations of the H109α line. Where possible, radio contours are compared with the optical picture of the H II region as determined by its Hα radiation. Although there is a general agreement between radio and optical features, marked differences are found in a detailed comparison. It seems that for most of the investigated H II regions the variation in optical surface brightness is to a large extent determined by obscuration by dust rather than by the emission measure. With a few exceptions, the exciting stars of compact H II regions could not be found, a fact that implies these stars are hidden behind a dense cocoon of dust, which seems to be capable of prevailing in the ultraviolet radiation field of an O star for a relatively long period. The radio center of a compact component in M8 coincides with the "hourglass" nebula, which might be part of the ionized cocoon of the O7 star Herschel 36. Centers of nonthermal emission of the two central OH lines are found to be closely associated with nearby compact H II regions. Velocity dispersions range between 1.2 and 16 km sec^{-1}; the projected distances range from 0.08 to 1.4 pc. Recent observations are consistent with the hypothesis that centers of nonthermal OH emission are protostars, i.e., dense condensations of neutral matter which are embedded in H II regions of low electron density. (auth)

22759 THE SPECTRUM OF DIFFUSE COSMIC X RAYS, 1 TO 13 keV. Gorenstein, P.; Kellogg, E. M.; Gursky, H. (American Science and Engineering, Cambridge, Mass.). Astrophys. J., 156: 315-24(Apr. 1969).

The cosmic x-ray background was measured in the energy range 1 to 13 keV during a sounding-rocket flight. The results reported here combined with data at higher energy indicate little, if any, change in the degree of spectral hardness between 1 and 60 keV, although there is evidence for some steepening at higher energies. The Crab Nebula was observed during the same rocket flight, and its x-ray spectral distribution is reported. Pulse-shape discrimination was used to eliminate non-x-ray background in the detectors, and the method of analysis of these kinds of data is presented. (auth)

22760 ASYMPTOTIC FORM FOR SYNCHROTRON SPECTRA BELOW RAZIN CUTOFF. Simon, M. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 156: 341-4(Apr. 1969).

Analytic formulae valid for frequencies below the Razin cutoff are calculated for the spectrum radiated by relativistic electrons. It is shown that, on the basis of available data, the positive curvature in the radio spectra of the variable extragalactic radio sources is probably not caused by the Razin effect. (auth)

22761 SYNCHROTRON RADIATION LOSSES IN SELF-ABSORBED RADIO SOURCES. McCray, Richard (California Inst. of Tech., Pasadena). Astrophys. J., 156: 329-39(Apr. 1969).

Radiative relaxation of a distribution of relativistic particles undergoing synchrotron radiation and reabsorption is considered. The particle distribution satisfies a Fokker–Planck equation, whose coefficients depend nonlinearly on the particle distribution through the radiation field. Approximate numerical solutions to the kinetic equation are obtained for a model homogeneous isotropic source. Effects of finite source size and of a high-energy cutoff in the particle distribution are always important. Reabsorption of radiation retards the relaxation of the particle distribution but only by a large factor. Its effects are most pronounced for distributions which are initially flat or increasing with energy. The characteristic radiation spectrum from a source of this type is described. Radiative relaxation alone cannot explain observed time variations of quasi-stellar radio spectra. (auth)

22762 OPTICAL POSITIONS OF RADIO SOURCES. Murray, C. A.; Tucker, R. H.; Clements, E. D. (Royal Greenwich Observatory, Hailsham, Eng.). Nature (London), 221: 1229(Mar. 29, 1969).

New optical positions are given for 16 radio sources with small angular diameters, which are suitable as calibration sources. The positions given are independent of all previous observations and do not depend on catalog positions or proper motions of reference stars. The data were obtained in 1967–68 with the 13- and 26-inch refractors and at the prime focus of the Isaac Newton telescope. Each source position was referred as closely as possible to the FK 4 system by means of observations of six or more BD stars. (UK)

22763 NEW THEORY OF QUASARS. Ahmad, S. M. W. Acta Phys. Pol., 35: 327-8(Feb. 1969).

A theory is proposed to account for the huge energy requirements of quasars in which the nucleons are broken up into quarks. A brief discussion is given. (W.D.M.)

22764 THE STUDY OF PULSARS WITH THE FIAN RADIO-TELESCOPE. Vitkevich, Viktor Vitol'dovich (Lebedev Inst. of

Physics, Moscow). Priroda, No. 10, 46-52(Oct. 1968). (In Russian).

A review of studies of pulsars at the Crimean station with the FIAN radiotelescope and at other stations is given. A description of receivers for the DKR-1000 radiotelescope is given. Data from Hughes' Laboratory in England are compared with Crimean studies. In particular, intensities measured by the Russians at 93 MHz during April and May on CP 1919 are at least 2 to 3 times more intense than those of the English group measured at 81.5 MHz during the preceding September to January. Several studies of the spectral distribution of intensity show correlation between intensity at 93 MHz and intensity at 92 MHz. Other correlations between intensities at 110 MHz and 70 MHz are noted. Correlations with the solar plasma are suggested; relations between the positions of the pulsars and the apparent trajectory of the Sun may affect interpretation of results. (BBB)

22765 NEWS OF PULSARS. Korets, M. A.; Ponizovskii, Z. L. Priroda, No. 10, 53-9(Oct. 1968). (In Russian).

As of June 1, 1968 the pulsars that had been found were CP 0834, CP 0950, CP 1133, and CP 1919. These had the following properties, respectively: period (sec), 1.27379 ± 0.00008, 0.25306467 ± 0.00000005, 1.18790928 ± 0.00000015, 1.33730113 ± 0.00000007; galactic latitude, 26°, 44°, 70°, 4°; $d\nu/dt$ (MHz/sec), 5.3 ± 0.5, 20 ± 5, 11.3 ± 3, 5.15 ± 0.03; N_e 1×10^{18} (electrons/cm^2), 36, 10, 18, 38; distance in light years assuming $N_e = 0.1$ cm^{-3} in interstellar space, 360, 100, 180, 380; spectral index, 1.3, 1.8, 1.3, 1.5. Interpretation of these observables is reviewed, including correlation with optical objects where possible. Various models have been suggested. The white-dwarf model is examined in more detail; more observations and calculations by theoreticians are surely necessary to assign an acceptable picture to the physical processes of pulsars. (BBB)

22766 11-cm RADIO SOURCES ASSOCIATED WITH CLUSTERS OF GALAXIES. Komesaroff, M. M.; Slee, O. B.; Higgins, C. S. (Commonwealth Scientific and Industrial Research, Organization, Sydney). Proc. Astron. Soc. Aust., 1: 102(Feb. 1968). (RPP-1160/3).

A survey of clusters of galaxies from Abell's catalog was carried out using the Mk II 11 cm receiver at Parkes. Only sources with flux densities down to ~0.3 f.u. were considered. Thirty-eight clusters were studied, of which 13 were found to contain radio sources within the above flux density range. The total number of such sources detected was 24, and the total area of sky surveyed was 33 square degrees, giving an average of 0.74 sources per square degree. (W.D.M.)

22767 STATISTICAL CORRELATIONS OF POSITION BETWEEN X-RAY SOURCES AND OPTICAL OBJECTS. Deupree, Robert (Univ. of Wisconsin, Madison). Publ. Astron. Soc. Pac., 81: 130-3(Apr. 1969).

The correlation coefficient is calculated comparing the distribution of galactic x-ray sources with each of the following optical objects: classical cepheids, old novae, planetary nebulae, and Wolf-Rayet stars. The results of this calculation are discussed with particular attention given to the completeness of each of the distributions used. (auth)

Solar Phenomena

Refer also to abstracts 22930, 22939, 22940, 23003, and 23020.

22768 (N-68-37841) FLOW PARAMETERS OF THE CORONA. Schocken, Klaus (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Sept. 27, 1968. 28p. (NASA-TM-X-53767). CFSTI.

The coronal plasma is assumed to be a fully ionized mixture of two species. Nondimensional parameters are obtained from the fundamental equations of plasma flow. Some thermodynamic properties of the coronal plasma are presented in tables which are based on a coronal model. (auth) (STAR)

22769 IONIZATION EQUILIBRIUM OF ELEMENTS BETWEEN CARBON AND NICKEL. Jordan, Carole (Culham Lab., Abingdon, Eng.). Mon. Notic. Roy. Astron. Soc., 142: 501-21(1969).

The ionization equilibrium N(ion)/N(element) for ions of elements abundant in the Sun was calculated as a function of temperature between $T_e \sim 10^{4}$°K and $\sim 10^{8}$°K. Two sets of results are given. The first includes the processes of collisional ionization, collisional excitation followed by autoionization, direct radiative recombination, radiative recombination via bound levels, and dielectronic recombination, reduced by a density-dependent term. As the variation of the electron density with electron temperature in the solar atmosphere enters into the calculations, these results are applicable only to the solar corona and chromosphere. The second set includes collisional ionization, collisional excitation followed by autoionization, direct radiative recombination, and the full dielectronic recombination rate. These results are applicable to any low-density plasma where the radiation field is negligible. (auth) (UK)

22770 ANNALS OF THE IQSY. VOLUME 3. THE PROTON FLARE PROJECT (THE JULY 1966 EVENT). Stickland, A. C. (ed.). International Years of the Quiet Sun. Cambridge, Mass., Massachusetts Institute of Technology, Press, 1969. 523p. $19.50. (In English and French).

The object of the Proton Flare Project was to obtain, through organized international cooperation, the most detailed set possible of observations on a selected proton flare event. The results of this cooperative study are given in the sixty-four papers of this volume. Separate abstracts were prepared for each of the papers. (W.D.M.)

For abstracts of individual papers see: 22771-22834.

22771 THE PROTON EVENT OF JULY 7, 1966: INTRODUCTORY. Simon, P. (Meudon Observatory, Paris). Ann. IQSY (Int. Years Quiet Sun), 3: 3-7(1969).

The purpose of the Proton Flare Project was to obtain detailed observations of at least one proton flare event from all possible aspects and to publish the results and conclusions from this co-operative study. Observations were co-ordinated by means of the International Ursigram and World Days Service, and a system of "alerts" was introduced to warn observers of the incidence of special conditions. Over 100 workers from 54 institutions and 18 countries collaborated in the project. (auth)

22772 THE MAGNETIC FIELDS AND PROTON FLARE OF JULY 7, 1966. Severnyi, A. (Crimean Astrophysical Observatory, Crimea, USSR). Ann. IQSY (Int. Years Quiet Sun), 3: 11-23(1969).

Longitudinal $H_{||}$ and transverse $H_{\perp}$ components of magnetic fields inside the active region which produced the proton flare of July 7, 1966, recorded with the aid of the double magnetograph of the Crimean Astrophysical Observatory, are considered. The mean gradients of the longitudinal field $\Delta H_{||}/\Delta S$ along the straight lines joining magnetic "hills" of the isogauss maps, the total magnetic flux over the active area $F_s + F_N$, and the difference of fluxes $F_s - F_N$ all behave similarly, showing small initial values (at July 4), then increasing to peak values before the flare (at July 6), and then dropping to small pre-flare values after the flare. The total magnetic energy $H_{||}^2/8\pi$ shows a similar behavior. These changes with time are more pronounced for lower levels (5250 Å) than for higher levels (6103 Å). The rotation of directions of the transverse field $H_{\perp}$ by 90° was found at the place where the flare appeared, if one compares these directions before and after the flare. The consideration of the behavior of the total vector $|H|$ and total energy $H^2/8\pi$ suggests the possibility that the bulk of magnetic tubes of force are pushed up from below, and then lowered. The two brightest clouds of the flare appeared simultaneously in regions of opposite magnetic polarity; one of the clouds is very close to neutron line $H_{||} = 0$ in the region of highest gradients $\Delta H_{||}/\Delta S$ and of the crossing (or bifurcation) of directions of transverse field $H_{\perp}$ as was found in earlier results. The comparison of these brightest clouds with distribution of vertical electric currents j_z over the area shows that the clouds are just above the points where the electric currents are strongest. (auth)

22773 DISTRIBUTION OF MAGNETIC FIELDS IN PHOTOSPHERIC AND CHROMOSPHERIC LAYERS IN THE ACTIVE REGION OF JULY 7, 1966 AND THEIR CORRELATION WITH THE FLARE EVENT OF JULY 8, 1253 TO 1340 UT. Brueckner, G. (Univ. of Maryland, College Park); Waldmeier, M. Ann. IQSY (Int. Years Quiet Sun), 3: 24-30(1969).

Longitudinal and transverse field components inside the very active region are determined with a spatial resolution of 2″ of arc by 2″ of arc measuring circular and linear polarization of the Fe I 5250 Å line. Also chromospheric fields are measured using the center of the Hα line. The interesting peculiarities of the field distribution are (a) the very active region shows a tripolar structure; the adjacent region of opposite polarity does not show any coincidence with a spot structure on July 7, 1966, 1200 MET, (b) the transverse component of the magnetic field has its maximum along the neutral line, (c) large field gradients can be observed at the neutral line, (d) the Hα magnetic field distribution in chromospheric layers shows much weaker fields than the photospheric field distribution, (e) the flare event appeared at both sides of one neutral line. (auth)

22774 THE $H\alpha$ PLAGE ASSOCIATED WITH THE PROTON FLARE OF JULY 1966. Popovici, C.; Dimitriu, A. (Bucharest Observatory). Ann. IQSY (Int. Years Quiet Sun), 3: 31-4 (1969).

The $H\alpha$ plage was a new-born plage between two old $H\alpha$ plages. Its development was slow and irregular at the beginning and accelerated rapidly on July 3, when within some eight hours the plage took on its compact, oval form along the axis of the sunspot group. The area of the plage increased to a flat maximum by July 6, three days before the maximum of the corrected area of the sunspot group; 12 hours before the proton flare the plage and the sunspot group took the characteristic A form, two parallel bright filaments extending from west to east symmetrical with the axis of the sunspot group and above the common penumbra of the spots, being brighter between the two principal spot umbrae of the group. (auth)

22775 BIRTH AND DEVELOPMENT OF THE CALCIUM PLAGE ASSOCIATED WITH THE PROTON FLARE OF JULY 1966. **Fortini, T.; Torelli, M. (Osservatorio Astronomico su Monte Mario, Rome). Ann. IQSY (Int. Years Quiet Sun), 3: 35-9(1969).**

Region 21034 may be considered as the fusion of two components born successively (with a difference in time of approximately 50 hours), 2° apart in longitude. The first part developed in the extreme periphery of an expanding old region, at a rather slow rate. Its separation from the old region was marked by the presence of a very dark supercellule. The second component developed and merged with the first component more freely. The largest spots after July 4, 1966 occupied the core of the region, a position rather unusual with respect to the general situation of spots in other regions. (auth)

22776 BIRTH AND DEVELOPMENT OF THE SUNSPOT GROUP ASSOCIATED WITH THE PROTON FLARE OF JULY 1966. **McIntosh, P. S. (Environmental Research Labs., Boulder, Colo.). Ann. IQSY (Int. Years Quiet Sun), 3: 40-3(1969).**

The birth and early development of the sunspot group consisted of the successive formation of three pairs of spot clusters on the borders of three adjoining network cells. The rapid growth and merging of the last two pairs resulted in a configuration of parallel rows of spots of opposite polarity enveloped in one continuous penumbra. The region between these rows exhibited umbrae elongated parallel to exceptionally dark and thick penumbral filaments. (auth)

22777 OBSERVATION OF PROTON FLARES: THE EVENT OF JULY 7, 1966: PHOTOMETRY OF THE 5303 AND 6374 A CORONAL LINES. **Leroy, J.-L. (Observatoire du Pic-du-Midi, Bagneres de Bigorre, France). Ann. IQSY (Int. Years Quiet Sun), 3: 44-6(1969). (In French).**

From observations collected simultaneously at the stations of Lomnický štít, Kislovodsk, Pic-du-Midi, and Wendelstein, synoptic charts for the 5303 Å and 6374 Å radiations were plotted. The isophotes display the distribution and time evolution of these coronal emissions in the solar active region where a proton flare appeared on July 7, 1966. (auth)

22778 CORONAL DATA FOR THE PERIOD OF THE PROTON FLARE EVENT OF JULY 1966. **Gnevyshev, M. N. (Astronomical Observatory, Pulkove, USSR). Ann. IQSY (Int. Years Quiet Sun), 3: 47-8(1969).**

Distribution curves of the coronal line intensity at 5303 and 6374 Å are given for the period of the July 1966 proton flare. (auth)

22779 CORONAL ELECTRON DENSITIES DURING THE PERIOD OF THE JULY 1966 PROTON FLARE. **Newkirk, G. Jr. (High Altitude Observatory, Boulder, Colo.); Hansen, R. T.; Hansen, S. Ann. IQSY (Int. Years Quiet Sun), 3: 49-62(1969).**

K-coronameter observations during the interval June to September 1966 were used to construct five electron density models of the corona above the proton flare region. These models were compared with others for the corona above active regions. The observations following the proton flares of July 10 and September 5 show the presence of a unique low-elevation condensation in the corona. The possibility that this condensation is the direct contribution of material expelled by the flares was examined. (auth)

22780 THE SLOWLY VARYING COMPONENT OF THE RADIO EMISSION DURING THE PERIOD OF THE JULY 1966 PROTON FLARE. **Tanaka, H.; Kakinuma, T.; Enome, S. (Nagoya Univ., Japan). Ann. IQSY (Int. Years Quiet Sun), 3: 63-9(1969).**

The results of observations made over the period of the proton flare of July 1966 with radio interferometers in various parts of the world over a wide range of frequencies between 1420 and 17,000 MHz are presented. A radio source was observed on July 1 and increased in intensity until the time of the proton event, after which it decayed gradually. The source was more obvious on 9400 MHz than on 4000 MHz in confirmation of observations by the authors in 1964, and it is proposed that proton flares should be predicted by an increase to or above unity of the ratio of the flux density of the slowly varying component at 9400 MHz to that at 4000 MHz. (auth)

22781 REMARKS ON THE SLOWLY VARYING COMPONENT OF SOLAR RADIO EMISSION DURING THE PROTON FLARE PERIOD OF JULY 1966. **Krueger, A. (Heinrich Hertz Inst. for Solar-Terrestrial Physics, Berlin-Adlershof). Ann. IQSY (Int. Years Quiet Sun), 3: 70-7(1969).**

The center of activity which produced the proton event of July 7, 1966 was characterized by an unusual increase of the slowly varying (S) component of solar radio emission at short centimeter waves. One day before the proton event a monotonic spectrum was present indicating a rapid growth of electron density. However, such a monotonic increase of the spectrum of the S component towards higher frequencies is not in every case a necessary condition for the occurrence of proton flares, as comparisons with the development of the S component in August and September 1966 show. (auth)

22782 THE SLOWLY VARYING COMPONENT OF SOLAR X-RAY EMISSION IN THE PERIOD JULY 1-15, 1966. **Friedman, H.; Kreplin, R. W. (Naval Research Lab., Washington, D. C.). Ann. IQSY (Int. Years Quiet Sun), 3: 78-81(1969).**

Solar x-ray monitoring by the Naval Research Laboratory's SOLRAD 8 Satellite (1965-93A) has provided a history of the Sun's x-ray emission for the particularly interesting period of early July 1966. The activation of plage region 8362 began on July 4 as indicated by increasing emission in the 0 to 8, 8 to 20, and 44 to 60 Å bands. By July 6, x-ray flux levels had increased by factors of 15, 5, and 1.6 in the 0 to 8, 8 to 20, and 44 to 60 Å bands respectively. (auth)

22783 FLARES IN THE ACTIVE REGION DURING THE PROTON FLARE PERIOD OF JULY 1966. **Bruzek, A. (Fraunhofer Inst., Freiburg i. B.). Ann. IQSY (Int. Years Quiet Sun), 3: 82-91(1969).**

Flare activity began on July 3 and had maximum intensity from July 6 to July 9. However, no really large event (importance 3 or 4) took place on the visible hemisphere. Three class 2B flares only occurred on the disk, the proton flare of July 7 being the most important event. Probably a great flare occurred behind the west limb on July 11. A total of 78 subflares, 35 importance 1 flares, and three importance 2B flares were observed in this active region from July 2 to 11. All minor flares as well as the origin and the brightest parts of the major flares lay close to spots, mainly inside the spot group in the rather narrow lane between the two rows of spots of opposite magnetic polarity. Only the major flares produced parts outside the spot group. Parallel strands were formed at least in rudimentary shape in a number of flares. (auth)

22784 PHOTOGRAPHY IN $H\alpha$, $H\beta$ AND D_3 OF THE ACTIVE PROMINENCE OF JULY 9, 1966. Leroy, J.-L. (Observatoire du Pic-du-Midi, Bagneres de Bigorre, France). Ann. IQSY (Int. Years Quiet Sun), 3: 92-5(1969). (In French).

Photographs were obtained of the large active solar prominence of July 9, 1966, through different monochromatic filters, which enable one to study separately characteristic emissions from hydrogen ($H\alpha$ and $H\beta$) and helium (D_3). One cannot find any important difference between prominence images obtained from these various radiations. (auth)

22785 ACTIVE PROMINENCES OF JULY 9 AND 11, 1966. **Gurtovenko, E. A.; Morozhenko, N. N.; Rakhubovskii, A. S. (Main Astronomical Observatory, Kiev). Ann. IQSY (Int. Years Quiet Sun), 3: 96-109(1969).**

The spectra of active prominences on July 9 and 11, 1966 were analyzed. The main peculiarity of the spectral line profiles is their loop-like shape which reveals the existence of large and complicated movements in the prominences under investigation. The physical conditions in the prominences were found to be the same as in quiescent prominences, but there was a sharp difference between them for turbulent velocities in the prominences of July 9 and 11, 1966: these were very large and were of the same order of magnitude as those which occur in limb flares. This "microturbulence" does not correspond to the normal distribution of velocities. (auth)

22786 POLARIZATION MEASUREMENTS OF THE PROTON FLARE ON JULY 11, 1966. **Stiber, G. (Lund Observatory, Sweden). Ann. IQSY (Int. Years Quiet Sun), 3: 110-12(1969).**

In the search for different sources of the continuous emission in solar limb objects, a program for determining polarization has been carried out at the Swedish Solar Observatory at Anacapri, Italy. The spectacular event on July 11, 1966 was found to have a polarization lower than that predicted by the theory of electron scattering. By special instrumental arrangements, the probable electron density was measured to be about 3×10^{11} electrons cm^{-3}. This value agrees well with the degree of polarization when one considers that the nonpolarized contribution to the continuous spectrum from the free–free and free–bound transitions of hydrogen increases with increasing electron density. The plane of polarization was found to be in good agreement with that to be expected if electron scattering were responsible for some of the continuous spectrum. (auth)

22787 THE WEST-LIMB ACTIVITY ON JULY 9, 10, 11, 1966 AS OBSERVED IN THE Hα LINE. Valnicek, B. (Ondrejov Observatory, Czech.); Godoli, G.; Mazzucconi, F. Ann. IQSY (Int. Years Quiet Sun), 3: 113-23(1969).

An analysis of the limb activity is given. The most important phenomena are the loop system, observed on July 9, and the eruptive prominence of July 11. By comparison of simultaneous observations with different bandwidth filters it was possible to establish the position of the phenomenon in three-dimensional space and thus to establish the twisted form of the July 11 phenomenon. From observations of radial velocity the unambiguous direction of motion could be determined. The uniform inclination of all the phenomena confirms the conclusion that above the active region there exists one constant system of magnetic fields. The analysis of velocity changes is important in connection with form changes of the prominence. (auth)

22788 RADIO BURSTS ASSOCIATED WITH ACTIVE REGION MCMATH NO. 8362 OF JULY 1966. **Yudin, O. (Gorky Univ., USSR); Kai, K. Ann. IQSY (Int. Years Quiet Sun), 3: 124-34 (1969).**

Observational data of radio bursts associated with an active region McMath No. 8362 in the range 1.76 cm to 13.5 m are given for the period July 2–11, 1966. In the period preceding the proton event of July 7, the noticeable increase of number and intensity of radio bursts at 3-cm wavelength range is greater than that in other wavelength ranges. After the proton flare on July 7 in the active region 8362 some comparatively greater bursts were observed: on July 8 at 0030 UT and 1706 UT, on July 9 at 0230 UT, and on July 11 at 0912.5 UT. (auth)

22789 REMARKS ON THE DEVELOPMENT AND ACTIVITY OF THE ACTIVE REGION DURING THE PROTON FLARE EVENT OF JULY 1966. **Krivsky, L. (Astronomical Inst., Ondrejov, Czech.). Ann. IQSY (Int. Years Quiet Sun), 3: 135-6(1969).**

By using the method of summation curves, some parameters of the development of the active region which produced the proton flare of July 1966 are derived. The method of summation curves demonstrates the main trends of the development of the active region, and with flares and sudden ionospheric disturbance effects gives a true picture of the dependence on time of the change of the energy loss. (auth)

22790 IONOSPHERIC EFFECTS OF X-RAY EMISSION FROM AN ACTIVE REGION WITH A PROTON FLARE (JUNE 30–JULY 11, 1966). **Krivsky, L. (Astronomical Inst., Ondrejov, Czech.); Nestorov, G. Ann. IQSY (Int. Years Quiet Sun), 3: 137-43(1969).**

To illustrate the time distribution trend of the occurrence of sudden ionospheric disturbance (SID) effects of all kinds caused by flares in this active region, a summation curve was constructed from the values I × D (I = importance, D = duration), and, for comparison, also the summation curve of solar flares. The slope of the summation curve of flares and SID effects gives a characteristic of the time distribution in the "energy loss" of the active region. The change of the ionospheric absorption in the D region during daytime is characterized by other summation curves. These are constructed from the field intensity recordings of long-wave transmitters. This absorption can be considered as a criterion for a slowly varying x emission of active regions on the Sun in a wider spectral range. With the second extraordinary phenomenon, the flare from July 11, 1966 behind the limb (13 to 21°), an atypical ionospheric effect had been recorded at a number of stations. However, the main part of the x emission flare source was hidden behind the disk, at least in this first phase of the flare development, since the usual typically rapid and intensive growth is absent in the sudden enhancement of atmospherics (SEA) effects and in the sudden cosmic-noise absorption effect. The harder "impulse" emission <1Å, which in other cases causes a very rapid growth of the SEA effect and an initial maximum, did not penetrate in this case into the lowest level of the D region. The first hard impulse x emission must originate in similar cases from altitudes lower than 20,000 km and the later emission in a wider range of the harder and softer x radiation originates in altitudes of 50,000 to 80,000 km. (auth)

22791 X-RAY EMISSION EVENTS PRECEDING THE PROTON FLARE OF JULY 7, 1966. **Friedman, H.; Kreplin, R. W. (Naval Research Lab., Washington, D. C.). Ann. IQSY (Int. Years Quiet Sun), 3: 144-53(1969).**

Solar x-ray emission on July 6 was characterized by a "storminess" in the 0 to 8 and 8 to 20 Å bands with 0 to 3 Å flux present above background levels on almost all telemetry records. This variable emission is found to originate from subflare activity in the plage region which produced the polar-cap absorption flare of July 7. (auth)

22792 THE BEHAVIOR OF THE ACTIVE REGION PRIOR TO THE PROTON FLARE JULY 7, 1966, BASED ON λ-SWEEP RECORDS. Dodson, H. W. (Univ. of Michigan, Pontiac). Ann. IQSY (Int. Years Quiet Sun), 3: 154-62(1969).

The eighteen λ sweeps secured between 1330 and 2232 UT on July 6, 1966 provided no evidence of Hα flares with unusually wide emission or great intensity. Only for the three subflares that began at about 2116, 2149, and 2222 UT respectively, was the onset of flare emission sufficiently sudden to lead to reasonably close agreement in reports from optical observers. No other flares were observed after these events and before the onset of the proton flare at July 7 0025 UT. Heavy absorption characterized the region. Rising and falling prominences were observed. Spectroheliograms made in K$_{1-2}$ emission indicated interesting phenomena in the lower levels of the chromosphere. The necessary circumstances for the occurrence of a proton flare apparently do not include a large number of impulsive, high-level, major flare phenomena during the preceding twelve hours. The role of absorption and the absence of detectable emission at 10-cm and meter wavelengths with the flares and subflares that did occur seem worthy of consideration. (auth)

22793 VARIATIONS IN THE ACTIVE REGION, MCMATH NO. 8362 PRIOR TO THE PROTON FLARE OF JULY 7, 1966. **Fisher, R. R.; Mann, G. R. (Univ. of Hawaii, Honolulu). Ann. IQSY (Int. Years Quiet Sun), 3: 163-8(1969).**

The active region around McMath plage #8362 was extensively observed by several observatories prior to the proton flare of July 7, 1966. This plage was associated with a Mount Wilson γ-type spot region. Nine subflares were observed before the event, starting about 7½ hours before the proton event. There was some modification of the disk structure and of a prominence to the east of the active region. Line-of-sight velocity fields were detected in this same region with an average of +1.8 km s^{-1} (toward the observer) for an extensive portion of the region. One subflare apparently produced a small surge of dark material, and this material's motion was strictly governed, presumably by complex magnetic fields. (auth)

22794 EVOLUTION OF THE SUNSPOT GROUP AFTER THE PROTON FLARE OF JULY 7, 1966. **McIntosh, P. S.; Sawyer, C. (Environmental Research Labs., Boulder, Colo.). Ann. IQSY (Int. Years Quiet Sun), 3: 169-74(1969).**

The total area of the sunspot group continued to increase for at least two days following the proton flare. However, the large umbrae near the center began to decay, even as rapid growth continued at both the leading and following ends of the group. The decline of the central umbrae, which underlie the brightest parts of the flare, began within half a day of the time of the flare, and was probably related to its occurrence. (auth)

22795 OPTICAL OBSERVATIONS OF THE PROTON FLARE OF JULY 7, 1966. **McCabe, M. K. (Univ. of Hawaii, Honolulu); Caldwell, P. A. Ann. IQSY (Int. Years Quiet Sun), 3: 175-80 (1969).**

The proton flare of July 7 was not a spectacular event from the optical point of view, but it showed several characteristics that have been previously observed in relation to flares which produce high-energy particles. The flare occurred in a magnetically complex sunspot group—Mount Wilson type γ. It showed a flash phase lasting about two minutes during the rise of intensity to a maximum. The flare had a Y-shaped phase with the long flare filament developing in a region between sunspots of opposite polarities and it covered several of the sunspot umbrae. The quality of the photographs obtained was not such as to make it possible to detect a flare nimbus after maximum, nor to identify any loop prominences in the region. A neighboring filament disappeared, but the process was not at all sudden, and any changes in the fine chromospheric structure surrounding the region were not detectable. (auth)

22796 THE DYNAMIC SPECTRUM OF THE PROTON EVENT OF JULY 7, 1966. **Stewart, R. T. (CSIRO Solar Observatory, Culgoora, Australia). Ann. IQSY (Int. Years Quiet Sun), 3: 181-3 (1969).**

The main features of the dynamic spectrum are a short-wave fade-out at 0027 UT and an intense burst of spectral Type II from 0038 to 0047 UT. No Type III bursts accompany the flash phase, but "herring-bone" structure is present between 0039 and 0045.5 UT. A second portion of Type III burst occurs from 0112 to 0113 UT. There is a suggestion of some weak continuum following the events described above, but its intensity is too low for positive identification. (auth)

22797 DECAMETRIC RADIO SPECTRA AND POSITIONS DURING THE FLARE OF JULY 7, 1966, 0041 UT. **Warwick, J. W. (Univ. of Colorado, Boulder). Ann. IQSY (Int. Years Quiet Sun), 3: 184-5 (1969).**

Boulder decametric spectra for this event exist only from 0053 UT to about 0200 UT and do not include the phases of pre-maximum or maximum emission. The data from the type-IV phase appear like those from other large events observed here and elsewhere. (auth)

22798 SINGLE-FREQUENCY BURSTS OBSERVED IN JAPAN DURING THE PROTON EVENT OF JULY 7, 1966. **Enome, S. (Nagoya Univ., Japan). Ann. IQSY (Int. Years Quiet Sun), 3: 186-9 (1969).**

A table and figures give the characteristics of the type-IV solar radio burst which started at 0018 UT on July 7, 1966, as observed in Japan at Mitaka, Hiraiso, and Toyokawa observing stations. (auth)

22799 THE COMPLETE TYPE IV BURST ASSOCIATED WITH THE JULY 7, 1966 PROTON EVENT. **Kai, K. (Tokyo Univ.). Ann. IQSY (Int. Years Quiet Sun), 3: 190-2 (1969).**

An attempt is made to provide all available data of the solar radio burst associated with the July 7, 1966 proton flare and to describe the characteristics of the burst as completely as possible. The combined dynamic spectrum is presented, drawn on the basis of both single-frequency and spectral observations. The burst is clearly of type IV, but it is characterized by the meter wave component which is much weaker than the high-frequency components and less persistent than usual. This may be attributed to the limb effect. (auth)

22800 VERY HIGH ENERGY SOLAR X RAYS OBSERVED DURING THE PROTON EVENT OF JULY 7, 1966. **Cline, T. L. (Goddard Space Flight Center, Greenbelt, Md.); Holt, S. S.; Hones, E. W. Jr. Ann. IQSY (Int. Years Quiet Sun), 3: 193-7 (1969).**

The time history and spectral intensity of solar x rays of energies from 80 to more than 500 keV were observed during the flare event of July 7, 1966. These measurements, made with the satellite OGO-3, cover the highest-energy range available thus far and show this event to have the greatest measured hard x-ray intensity of any solar event studied in detail to date. Three intensity peaks at about 0027, 0029, and 0037 UT coincide with the times of microwave intensity maxima. A study of the spectral and temporal features of the x-ray emission, and comparison with the radio data, indicate a nonthermal bremsstrahlung origin for the x rays. (auth)

22801 THE SOLAR X-RAY FLARE OF JULY 7, 1966. **van Allen, J. A. (Univ. of Iowa, Iowa City). Ann. IQSY (Int. Years Quiet Sun), 3: 198-201 (1969).**

A major solar x-ray flare was observed on July 7, 1966 by Explorer 33. Details of the detector are given. The maximum intensity of the x-ray flare occurred at 0042 UT and reached a value 28 times that of the pre-flare ambient value. The x-ray flare is attributed to the McMath plage region 8362. There is general overall resemblance to solar radio noise at 2700 MHz and detailed resemblance to ionospheric D-layer absorption of cosmic radio noise at 22 MHz. (auth)

22802 X-RAY EMISSION FROM THE PROTON FLARE OF JULY 7, 1966. **Friedman, H.; Kreplin, R. W. (Naval Research Lab., Washington, D. C.). Ann. IQSY (Int. Years Quiet Sun), 3: 202-3 (1969).**

Although the start of the polar-cap absorption flare did not coincide with a ground-station telemetry recording, the levels were far above saturation values one and one-half hours after the flare began. The decay of x-ray emission was very slow; about six hours elapsed before the x-ray emission returned to pre-flare levels. (auth)

22803 THE X-RAY AND EXTREME ULTRAVIOLET RADIATION OF THE JULY 7, 1966 PROTON FLARE AS DEDUCED FROM SUDDEN IONOSPHERIC DISTURBANCE DATA. **Donnelly, R. F. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Ann. IQSY (Int. Years Quiet Sun), 3: 204-8 (1969).**

The x-ray and extreme ultraviolet radiation deduced from sudden ionospheric disturbances are discussed for the solar flare of 0026 UT, July 7, 1966. Estimates are given as a function of time for the flare radiation in the 0.3 to 1, 0.2 to 2, 0.2 to 5, 0.2 to 10, and 10 to 1030 Å wavelength ranges. The time dependence of these radiations is compared with solar radio emission. (auth)

22804 THE GEOMAGNETIC CROCHET OF JULY 7, 1966. **Pinter, S. (Geomagnetic Observatory, Hurbanovo, Czech.). Ann. IQSY (Int. Years Quiet Sun), 3: 209-14 (1969).**

The geomagnetic crochet began at 0026 UT with a sudden short impulse. It then expanded more slowly, as is characteristic for a crochet associated with the proton flares. The geomagnetic crochet reached its maximum about 0046 UT and was over at about 0230 UT. During the period of increase of the crochet to its maximum value, geomagnetic pulsations occurred. The pulsations are characterized by their irregular form with a variable period from 40 to 100 seconds. The geomagnetic crochet is detectable not only in the sunlit hemisphere but also in the dark hemisphere. The time of maximum of the crochet is not simultaneous all over the world, but shows a systematic time lag in the sunlit hemisphere, i.e., the maximum stage at each station takes place later with increasing distance from the sub-solar point on the Earth. The value of the product of the recombination coefficient and the electron density of the D region of the ionosphere $(\alpha N)_D$ was determined on the basis of the duration of the decrease of the horizontal component of the geomagnetic crochet from maximum to normal value. The value of $(\alpha N)_D$ is then about 1.8×10^{-4} s^{-1}. (auth)

22805 LATER DEVELOPMENT OF THE CENTER OF ACTIVITY OF THE PROTON FLARE, JULY 7, 1966: OPTICAL OBSERVATIONS. **Dodson, H. W.; Hedeman, E. R. (Univ. of Michigan, Pontiac). Ann. IQSY (Int. Years Quiet Sun), 3: 215-21 (1969).**

The center of activity that was the site of a proton flare on July 7, 1966 continued through at least two subsequent rotations. In the first of these, in late July, spot area and radio emission were greatly diminished, but the calcium plage had increased in area by 50%. Flares continued to occur in the region, and the major flare of July 28 is of special interest. In the August rotation, the post-proton region of July at latitude 33°N through differential rotation became co-longitudinal at 182° with a previously following region in latitude 22°N. This region at lower latitude produced major proton flares on August 28 and September 2. (auth)

22806 MAGNETIC FIELD DECAY IN THE GROUP 21034 DURING THE PROTON FLARE PERIOD OF JULY 1966. **Mogilevskii, E. I.; Demkina, L. B.; Dolginova, Yu. N.; Ioshpa, B. A.; Obridko, V. N.; Shelting, B. D.; Zhulin, I. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Ann. IQSY (Int. Years Quiet Sun), 3: 222-8 (1969).**

It has been noted that while considering magnetic field decay after the flare, one can make only detailed photographic measurements of the spot-group field because the region of Hα radiation in the proton flare is closely connected with the distribution of the magnetic field of the spot group. For two groups of spots (No. 21034 and 18521) of the Proton Flare Project program, in which proton flares were observed, a similarity of magnetic field structure has been emphasized. After the proton event of July 7 in the group 21034 a sudden growth of S-polarity magnetic flux and considerable decrease of N-polarity flux were observed. During the next rotation of the Sun the group 21034 was observed continuously as a slowly decaying unipolar spot of S-polarity with the magnetic class "αp." (auth)

22807 ON THE DEVELOPMENT AND ACTIVITY OF THE ACTIVE REGION ASSOCIATED WITH THE PROTON FLARE EVENT OF JULY 1966: SUMMARY OF OBSERVATIONS AND CONCLUSIONS. **Banin, V. (SibIZMIR, Irkutsk, USSR); de Feiter, L. D.; Fokker, A. D.; Martres, M. J.; Pick, M. Ann. IQSY (Int. Years Quiet Sun), 3: 229-41 (1969).**

The solar active region respectively named by Mount Wilson, McMath, and Meudon observatories as 16067, 8362, and 150915 was located at 210° and 34°N. In the first part of this paper the most important observations as derived from the different contributions are discussed and compared. The second part deals with the specific features of the proton flare. In conclusion some properties of the active region which could appear as conditions that are necessary for the preparation and production of proton flares are discussed. (auth)

22808 THE GROUND-LEVEL SOLAR PROTON EVENT OF JULY 7, 1966 RECORDED BY NEUTRON MONITORS. **Carmichael, H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Ann. IQSY (Int. Years Quiet Sun), 3: 245-53(1969).**

Graphs are presented for ground-level neutron monitor observations at 34 stations. A ground-level solar proton event was detectable at some stations. Observations at Alert indicated that the solar particles arrived most strongly and promptly from the north in a direction perpendicular to the ecliptic, and observations at Leeds indicated the presence of particles of magnetic rigidity in excess of 2.2 GV. (auth)

22809 THE INCREASE IN LOW-ENERGY COSMIC RAY INTENSITY ON JULY 7, 1966. **Ahluwalia, H. S.; Sud, L. V.; Schreier, M. (Univ. Mayor de San Andres, La Paz, Bolivia). Ann. IQSY (Int. Years Quiet Sun), 3: 254-66(1969).**

Some stations of the high-latitude network of high counting rate neutron monitors with vertical cut-off rigidity up to 2.3 GV registered a sharp simultaneous and rather conspicuous small increase between 0100 and 0300 UT on July 7, 1966. No increase was observed with meson telescopes at the same sites. The increase is the smallest ever recorded by ground-level detectors and is associated with the class 2B solar flare which occurred on the same day at 0020 UT in the McMath plage region 8362 with heliographic coordinates 34°N 47°W. The flare thus turns out to be in the most northerly location so far known to produce increase of cosmic-ray intensity in ground-level detectors. It is conjectured that the solar protons which produced the ground-level increase reached the Earth after considerable scattering— they might have been deviated over 30° from the radial direction. Deductions as to the configuration of the prevalent interplanetary magnetic field and the propagation characteristics of solar protons are discussed. (auth)

22810 BALLOON MEASUREMENTS OF SOLAR PROTONS IN NORTHERN SCANDINAVIA ON JULY 7, 1966. **Heristchi, Dj. (Laboratoire de Physique Cosmique, Meudon, France); Kangas, J.; Kremser, G.; Legrand, J. P.; Masse, P.; Palous, M.; Pfotzer, G.; Riedler, W.; Wilhelm, K. Ann. IQSY (Int. Years Quiet Sun), 3: 267-81(1969).**

Following the flare of importance 2B of July 7, 1966, 0020 UT, proton measurements were obtained from two balloon flights in northern Scandinavia. At balloon altitudes the integral proton flux ($E_p > 100$ MeV) increased from 0110 UT onwards. The maximum proton flux of 2.6 protons cm^{-2} s^{-1} sr^{-1} was reached at 0205 UT. The following decrease could be observed until about 2230 UT, when the detector stopped working. The exponent γ of the power law representing the differential energy spectrum was deduced for $E_p > 100$ MeV from the ratio of the counting rates of a single omnidirectional counter and a counter telescope. Up to about 0600 UT, γ increased from about 2 to 3.5 and then varied between 3.5 and 3.8. Another estimate of γ by measuring the range spectrum of the protons was in good agreement with these values. The differential proton flux was calculated for several energies, using the above deduced values for γ and the counting rates of the telescope. The maximum of the differential flux occurred at about 0500 UT, 0400 UT, and 0230 UT for 100-, 150-, and 200-MeV protons, respectively. The time variations of the proton flux could be explained with the formalism of diffusion theory as has been done for the special case of solar protons by Krimigis. A diffusion coefficient varying with the distance from the Sun according to $D = D_0 r^{1.1}$ was needed. The mean free path L was estimated to be about 0.05 AU. The total number N of protons emitted during the flare can also be estimated by this method and is found to be $N \simeq 10^{31}$ sr^{-1}. (auth)

22811 THE PROTON FLARES ON JULY 7, SEPTEMBER 2, 1966, AND JANUARY 28, 1967. **Ageshin, P. N.; Boyarevich, V. V.; Stozhkov, Yu. I.; Charakhchyan, A. N.; Charakhchyan, T. N. (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Ann. IQSY (Int. Years Quiet Sun), 3: 282-7(1969).**

The cases of the increases in the cosmic-ray intensity on July 7, September 2, 1966, and January 28, 1967 were detected in the stratosphere in the Murmansk region (Olenya station) and at Mirny (the Antarctic). The energy spectrum and time dependences of the solar-proton intensity were measured. The exponent γ of the integral energy spectrum of the solar protons in the 200 to 300-MeV energy range proved to be equal to $\gamma \simeq 2.4$ for the flare of July 7, $\gamma \simeq 3.7$ for the flare of September 2, $\gamma \simeq 3.0$ for the flare of January 28. The maximum proton flux detected in the flare of January 28 at 1250 UT was about 1.8×10^6 particles cm^{-2} s^{-1} sr^{-1}. (auth)

22812 SEA-LEVEL OBSERVATIONS OF THE JULY 7, 1966 SOLAR PROTON EVENT. **Freon, A.; Berry, J.; Folques, J. (Laboratoire de Physique Cosmique, Fort de Verrieres, France). Ann. IQSY (Int. Years Quiet Sun), 3: 288-94(1969).**

From the beginning of the present solar cycle, the July 7, 1966 proton event is the first to give obvious effects in ground-level cosmic-ray detectors. Rather low but noticeable increases against background have been observed by several high-rate neutron monitors (NM 64), the two largest ones being recorded at Alert, Alaska, and Port-aux-Français, Archipelago Kerguelen. These results are analyzed, especially the latter, in comparison with high-altitude measurements with balloon-borne detectors in Northern Scandinavia. The main results are the following: it seems not to be necessary to assume an anisotropic distribution on Earth of the solar particles to explain the relatively high increase observed at Kerguelen; the maximum momentum of the solar protons is of the order of 1.5 to 2 GeV/c; the proton event has been observed at ground level up to 0520 UT, i.e., during the whole increasing period of the exponent of the power law spectrum of the particle energy; the variations observed at sea level during the decrease of the event are probably related to the observed structure at balloon altitudes showing a second maximum. (auth)

22813 RELATIVISTIC SOLAR ELECTRONS DETECTED DURING THE JULY 7, 1966 PROTON FLARE EVENT. **Cline, T. L.; McDonald, F. B. (Goddard Space Flight Center, Greenbelt, Md.). Ann. IQSY (Int. Years Quiet Sun), 3: 295-8(1969).**

The July 7, 1966 flare event provided the first opportunity to detect relativistic solar electrons in interplanetary space. The solar electrons, observed with the satellite IMP-3, have energies between 3 and 12 MeV, nearly two orders of magnitudes higher than any previously studied in space. Since they are relativistic electrons, they therefore provide a new parameter in the study of solar-particle events. The electrons were separable from low-energy solar protons for several hours following the flare of 0027 UT and were, in fact, the only detectable low-energy particles between 0100 and 0200 UT. The electron energy spectrum and complete time history were measured from a position outside geomagnetic influence and show a compatibility with the general diffusion picture, having a delayed onset and profile similar to the high-velocity proton histories of other events. Other features of the event are outlined in this note. (auth)

22814 SPATIAL GRADIENTS OF ENERGETIC PROTONS AND ELECTRONS OBSERVED AFTER THE JULY 7, 1966 SOLAR FLARE. **Kahler, S. W.; Lin, R. P. (Univ. of California, Berkeley). Ann. IQSY (Int. Years Quiet Sun), 3: 299-312(1969).**

Simultaneous observations of the July 7–9, 1966 solar particle event by energetic particle detectors on three satellites, IMP-3, OGO-3, and Explorer 33 are utilized to show that large spatial gradients are present in the fluxes of 0.5 to 20-MeV protons and ≳45-keV electrons. The event is divided into three parts: the ordinary diffusive component, the halo, and the core. The core co-rotates with the interplanetary field, and therefore it and the surrounding halo are interpreted as spatial features which are connected by the interplanetary magnetic field lines to the vicinity of the flare region. Upper limits to the interplanetary transverse diffusion coefficient at 1 AU are derived from the width of the halo for 3 to 20-MeV protons. These are at least two orders of magnitude less than the parallel diffusion coefficient for particles of the same energy. It is argued that the observed flux variations cannot be explained by an impulsive point source injection for any physically reasonable diffusion model. Instead, since the interplanetary transverse diffusion coefficient is small for these low-energy particles, the observed spatial features are interpreted as the projection to 1 AU by the interplanetary field lines of an extensive injection profile at the Sun. The geometry of the injection mechanism is discussed and it is suggested that some temporary storage of the flare particles occurs in the solar atmosphere. (auth)

22815 OBSERVATIONS OF THE SOLAR PARTICLE EVENT OF JULY 7, 1966 WITH UNIVERSITY OF IOWA DETECTORS. **Armstrong, T. P.; Krimigis, S. M.; Van Allen, J. A. (Univ. of Iowa, Iowa City). Ann. IQSY (Int. Years Quiet Sun), 3: 313-28 (1969).**

Nearly complete time histories from July 7 to July 17 of the intensities of 0.31 to 10-MeV protons and of 2.1 to 17-MeV alpha particles emitted from the solar flare of 0023 UT on July 7, 1966 were obtained with particle detectors on Explorer 33. The peak intensity of 3.5×10^3 $(cm^2\ s\ sr\ MeV)^{-1}$ of 0.82 to 1.9-MeV protons occurred between 1000 and 1100 UT on July 8, approximately 34 hours after the flare. At the same time the peak intensity of 2.1 to 17-MeV alpha particles was 190 $(cm^2\ s\ sr)^{-1}$. The abundance ratio of protons to alpha particles was measured for the first time in the energy range from 0.5 to 4 MeV/nucleon and was found to range from 28 to 55 in this event. The time profiles of protons and alpha particles were complex and rapid variations of proton intensities were observed to occur in times as small as 82 seconds, the interval between data samples. (auth)

22816 PIONEER 6 OBSERVATIONS OF THE SOLAR FLARE PARTICLE EVENT OF JULY 7, 1966. Rao, U. R. (Physical Research Lab., Ahmedabad, India); McCracken, K. G.; Bukata, R. P. Ann. IQSY (Int. Years Quiet Sun), 3: 329-36(1969).

The solar-flare effects and Forbush decrease occurring during the period July 5–15, 1966, as observed by a detector on the Pioneer 6 spacecraft some 45° away from Earth in solar longitude, are discussed. It is concluded that the phenomena observed throughout the interval are completely typical of solar-flare effects: thus a nonequilibrium anisotropy was observed from the "garden hose" direction at early times, a bi-directional anisotropy was observed subsequent to the onset of the Forbush decrease, and an equilibrium anisotropy due to convective removal of the cosmic rays from the solar system was observed at late times during the period. It is inferred that the velocity of propagation of the plasma disturbance responsible for the Forbush decrease was not significantly different (±25%) over a range of 45° of heliographic longitude. (auth)

22817 THE POLAR-CAP ABSORPTION ON JULY 7–10, 1966. Hakura, Y. (Goddard Space Flight Center, Greenbelt, Md.). Ann. IQSY (Int. Years Quiet Sun), 3: 337-52(1969).

The time history of a polar-cap absorption (PCA) on July 7–10, 1966 was analyzed using 16 riometers in the northern polar region and concurrent satellite observations of solar cosmic radiations. The first onset of PCA was noticed at 0120 UT at Shepherd Bay, Canada, which is located 10° from the North Pole, and the slight enhanced ionization of a few tenths of 1 dB covered the whole North Pole region before 0200 UT. On the other hand, auroral zone stations observed the PCA after 0200. The two-stepped onset of the PCA corresponds to the differential arrival of ionizing electrons and protons at the Earth, detected by the satellites. The flux of 40-keV electron bursts observed by the satellites Explorer 33 and IMP-3 can explain the first onset of a slight PCA near the geomagnetic pole. The PCA in the polar region marked a maximum of 2.5 dB on 30 MHz at 1300 on July 7, and then decayed gradually until it went down below 0.3 dB after 2345 on July 8. The lowest latitude of the PCA during the geomagnetically calm period was some 63° in corrected geomagnetic latitude. After the onset of geomagnetic disturbances, the PCA superposed upon it the auroral zone absorption (AZA) that appeared even in the lower auroral zone. (auth)

22818 THE JULY 7, 1966 SOLAR COSMIC-RAY EVENT. Masley, A. J.; Goedeke, A. D. (Douglas Missile and Space Systems Div., Santa Monica, Calif.). Ann IQSY (Int. Years Quiet Sun), 3: 353-5(1969).

Absorption was in progress at 0120 UT on July 7, 1966, when the sudden cosmic-noise absorption (SCNA) was reduced and particle absorption began to dominate. This start time, indicating about a one-hour delay from the flare start time, is in good agreement with satellite observations. The absorption reached a maximum of near 2 dB at 1220 UT on July 7, decayed steadily to 0.3 dB during the next 36 hours and stayed near this level for several days. The event was observed in continuous daylight at Shepherd Bay while McMurdo was in continuous darkness. This paper is based on observations with 30 and 50 MHz riometers at the Douglas observatories (80° magnetic latitude). Measured absorption is proportional to the square root of the particle intensity. (auth)

22819 VERY LOW RADIO FREQUENCY OBSERVATIONS OF THE SOLAR FLARE AND POLAR-CAP ABSORPTION EVENT OF JULY 7, 1966. Crary, J. H.; Crombie, D. D. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Ann. IQSY (Int. Years Quiet Sun), 3: 356-65(1969).

The solar flare of July 7, 1966 produced normal sudden phase anomalies and amplitude increases on very low frequency signals received over sunlit paths, while identifiable effects of the resulting polar-cap event were observed on two northern polar-cap paths, namely Criggion to Anchorage and Seattle to Frankfurt. No effects of comparable magnitude were observed on the polar path from Hawaii to Frankfurt. The presence or absence of disturbances on these and other paths is used to define the area in which the polar-cap event caused vlf effects. After making assumptions as to the actual length of the Seattle to Frankfurt path which was affected, it was deduced that the mean change in effective height of reflection was between 13 km and 27 km. Although it is not possible to trace the return of the height of reflection to its normal value, the attenuation on this path did not return to normal until about 30 hours after the onset of the polar-cap event. (auth)

22820 OBSERVATIONS OF THE INTERPLANETARY MAGNETIC FIELD, JULY 4–12, 1966. Ness, N. F.; Taylor, H. E. (Goddard Space Flight Center, Greenbelt, Md.). Ann. IQSY (Int. Years Quiet Sun), 3: 366-74(1969).

Simultaneous interplanetary magnetic field measurements by geocentric satellites Explorer 33 and IMP-3 were made of the magnetohydrodynamic shock wave associated with the sudden commencement storm at 2102 on July 8, 1966. Detailed analysis of the arrival time and orientation of the shock surface and shock normals show that the surface was not perpendicular to the Sun–Earth line and velocity had decreased so that at 1 AU it was less than 710 km s^{-1} compared with the average velocity of 950 km s^{-1} computed from the transit time from the parent solar flare class 2B on July 7, 1966. (auth)

22821 OBSERVATIONS OF THE INTERPLANETARY PLASMA SUBSEQUENT TO THE JULY 7, 1966 PROTON FLARE. Lazarus, A. J.; Binsack, J. H. (Massachusetts Inst. of Tech., Cambridge). Ann. IQSY (Int. Years Quiet Sun), 3: 378-85(1969).

Changes in plasma conditions subsequent to the July 7, 1966 flare were monitored by detectors on Pioneer 6 and on Explorer 33. During the period of observations, Pioneer 6 was located 0.84 AU from the Sun at a heliocentric longitude of 45° relative to Earth. Thus, the July 7 flare was close to central meridian for Pioneer 6. Explorer 33 was beyond the bow shock, and monitored interplanetary conditions in the vicinity of the Earth. A comparison is made of the changes in plasma properties observed on these two satellites during the post-flare period. (auth)

22822 DETECTION OF PERTURBATIONS IN THE MAGNETOSPHERE BY MEANS OF RADIOELECTRIC WHISTLINGS AS A SEQUENCE OF THE PROTON EVENT OF JULY 7, 1966. Corcuff, Y. (Faculte des Sciences, Poitiers, France). Ann. IQSY (Int. Years Quiet Sun), 3: 386-8(1969). (In French).

The analysis of whistlers received at mean latitudes and at Byrd Station in the Antarctic from July 6 to 14, 1966, provides some magnetospheric information. An important motion of the plasmapause toward the Earth occurred on July 8 between 02 and 14 UT; the geocentric distance of this transition region was near 5.5 R_E on July 6 and 7 but only 3 to 4 R_E from July 9 to 14. The electron density of the thermal plasmasphere, the part of the magnetosphere that is limited toward the outside by the plasmapause, tended to increase on the night of July 8–9. This contraction of the plasmasphere, which seems to precede the magnetic storm beginning on July 8 at 2102 UT, was also observed by the OGO-3 satellite on July 9. (tr-auth)

22823 THE FORBUSH DECREASE ASSOCIATED WITH THE PROTON EVENT OF JULY 7, 1966 AS RECORDED BY NEUTRON MONITORS. Carmichael, H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Ann. IQSY (Int. Years Quiet Sun), 3: 376-7 (1969).

Observations of cosmic-ray intensity variations in different directions in space were made by neutron monitors at a number of stations, and are presented graphically. The two north- and south-pointing stations showed a 3% intensity decrease almost simultaneously; decreases at other stations were not simultaneous indicating anisotropic flux. (auth)

22824 EVIDENCE OF CONTRACTION OF THE EARTH'S THERMAL PLASMASPHERE SUBSEQUENT TO THE SOLAR FLARE EVENTS OF JULY 7 and 9, 1966. Taylor, H. A. Jr.; Brinton, H. C.; Pharo III, W. M. (Goddard Space Flight Center, Greenbelt, Md.). Ann. IQSY (Int. Years Quiet Sun), 3: 389-94 (1969).

Direct measurements of thermal H^+ and He^+ in the magnetosphere were obtained from ion mass spectrometers on OGO 1 and 3. Typical H^+ profiles exhibit a gradual decrease in concentration with altitude within the plasmasphere, while the outer boundary of the plasmasphere is characterized by an abrupt decrease in concentration to 5 ions cm^{-3} or less. This boundary, the plasmapause, is observed to move inward and outward in an inverse correlation with the magnetic activity index Kp. The magnetosphere was disturbed during the solar flare period July 7–9, 1966, and on July 9 the plasmapause was observed to be unusually low, at L = 3.3. This observation contrasted with measurements of the plasmapause on both preceding and succeeding orbits, when in the absence of flares and magnetic disturbance the H^+ boundary was observed to expand to L values as high as 6. These measurements correlate well with "knee" whistler observations of the plasmapause. (auth)

22825 SOLAR PARTICLE OBSERVATIONS INSIDE THE MAGNETOSPHERE DURING THE JULY 7, 1966 PROTON FLARE

EVENT. Krimigis, S. J.; Van Allen, J. A.; Armstrong, T. P. (Univ. of Iowa, Iowa City). Ann. IQSY (Int. Years Quiet Sun), 3: 395-407(1969).

Observations of protons emitted by the July 7, 1966 solar flare at 34°N 47°W with the low-altitude–high-latitude Injun 4 show the following: (a) High energy ($E_p \sim 27$ MeV) protons arrive promptly over the Earth's polar caps and decay in a manner consistent with diffusive propagation. (b) The counting rate due to protons in the interval $0.52 \leq E_p \leq 4$ MeV and moving normal to the magnetic vector shows a double plateau as the satellite moves over the polar caps. (c) The position of the "knee" for protons in the above energy interval varies from $L \sim 7.5$ to $L \sim 6.3$ at magnetic local times of about 04.5 hours and 11.5 hours, respectively. (d) After the sudden commencement the latitude gap between trapped protons and solar protons disappears, suggesting that some solar protons may become trapped in the radiation belts. (e) Simultaneous observations with similar detectors inside the magnetosphere (Injun 4) and outside the magnetosphere (Explorer 33) show that low-energy (~0.5 MeV) protons have essentially immediate access from the interplanetary space to the polar caps of the Earth. Finally, the theoretical implications of these results are discussed. (auth)

22826 PRELIMINARY ANALYSIS OF MICROPULSATIONS OF THE EARTH'S ELECTROMAGNETIC FIELD IN CONNECTION WITH THE PROTON FLARE OF JULY 7, 1966. Matveeva, E. T.; Troitskaya, V. A. (Academy of Sciences, Moscow). Ann. IQSY (Int. Years Quiet Sun), 3: 408-12(1969).

The results of analysis of the behavior of micropulsations at 12 observatories located in polar caps, auroral zones, and middle latitudes are given for the first half of July 1966. It is revealed that there are some peculiarities in the occurrence of pearls before and after the flare. Before the flare only pulsations with periods greater than 3 sec are observed and only in high latitudes. After the flare world-wide generation of pearls with periods less than 3 sec was traced. It is suggested that their occurrence is an indication of penetration of energetic particles in the magnetosphere. (auth)

22827 THE VARIATIONS OF THE GEOMAGNETIC FIELD IN MIDDLE AND HIGH LATITUDES DURING THE PROTON FLARE EVENT OF JULY 1966. Best, A.; Fanselau, G.; Grafe, A.; Lehmann, H.-R.; Wagner, Chr.-Ulr. (Geomagnetic Inst., Potsdam, Ger.). Ann. IQSY (Int. Years Quiet Sun), 3: 413-25 (1969).

The present summary gives a general survey of magnetic activity. The magnetic records indicate that a general rather than a sudden increase of ultraviolet radiation is associated with the proton flare. The Dst component for a geomagnetic latitude of about 51.5°N and the current systems at the polar cap and the auroral zone are given and discussed for different times of the geomagnetic disturbance following the proton flare. Also discussed are the period spectra and the energy spectra of the variations occurring during the main phase of the storm for observatories in different latitudes. (auth)

22828 IONOSPHERIC CONDITIONS FOLLOWING THE PROTON FLARE OF JULY 7, 1966 AS DEDUCED FROM TOPSIDE SOUNDINGS. Herzberg, L.; Nelms, G. L. (Radio Physics Lab., Ottawa). Ann. IQSY (Int. Years Quiet Sun), 3: 426-36(1969).

Following the solar proton flare of July 7, 1966, two unusual conditions of the ionosphere were observed with the topside sounders of the Alouette satellites: (1) the G condition, a phenomenon observed on earlier occasions during magnetic storms, where, from the topside, the F1 layer becomes visible below the F2 layer; (2) a new condition, provisionally named Σ condition, whose presence is recognized by the occurrence of narrow dark bands crossing the reflection trace of Alouette 2 ionograms at low frequencies where the frequency resolution is relatively large. The bands are tentatively interpreted as narrow vertical regions of electron density depletion ("minitroughs"), possibly connected with a stationary hydromagnetic wave. The correlation of the sounder results with particle counter and plasma probe data is discussed. (auth)

22829 IONOSPHERIC CONDITIONS FOLLOWING THE PROTON FLARE EVENT OF JULY 7, 1966 AS MEASURED AT GROUND-BASED STATIONS. I. LOW-ENERGY PARTICLE EFFECTS IN THE LOWER IONOSPHERE AT MEDIUM LATITUDES. Knuth, R.; Lauter, E. A. (Observatory for Ionospheric Research, Kuehlungsborn, Ger.). Ann. IQSY (Int. Years Quiet Sun), 3: 437-42(1969).

The results of the particle effects in medium latitudes in the lower ionosphere during the storm-time period following the proton flare event was a small but detectable event which follows the normal behavior, i.e., a sudden increase of absorption during the primary magnetic storm effect (decrease in H), lasting a few hours, followed by a small but significant after-effect arising from temporary trapping processes in the outer radiation belt. (auth)

22830 IONOSPHERIC CONDITIONS FOLLOWING THE PROTON FLARE EVENT OF JULY 7, 1966 AS MEASURED AT GROUND-BASED STATIONS: II. F REGION EFFECTS. Lange, H.; Taubenheim, J. (Heinrich-Hertz-Institut, Berlin-Adlershof). Ann. IQSY (Int. Years Quiet Sun), 3: 443-7(1969).

The F-region response to the July 7, 1966 proton flare event, over the European and Asian regions, is characterized by a two-phase ionospheric storm, starting with a positive phase in high and medium latitudes, followed by a two-step decrease of f_0F2, beginning earlier than the main phase of the geomagnetic storm. At 60° geomagnetic latitude, the maximum positive phase is reached at a time 33.9 hours after the proton flare. The characteristic features of the f_0F2 time variation during the disturbance show a significant propagation from higher towards lower geomagnetic latitudes, and from eastern towards western geographic longitudes. (auth)

22831 IONOSPHERIC DISTURBANCES AFTER THE PROTON FLARE OF JULY 7, 1966. Benkova, N. P.; Zevakina, R. A. (IZMIRAN, Moscow). Ann. IQSY (Int. Years Quiet Sun), 3: 448-56(1969).

Ionospheric effects caused by the enhancement of solar radiation, high-energy protons, and low-energy solar plasma radiated during the proton flare were considered using the vertical sounding and riometer data of the Soviet stations in Arctic, Antarctic, and at middle latitudes. (auth)

22832 SUMMARY ON ENERGETIC PARTICLES OBSERVED DURING THE JULY 1966 PROTON FLARE EVENT. Krimigis, S. M. (Univ. of Iowa, Iowa City). Ann. IQSY (Int. Years Quiet Sun), 3: 457-61(1969).

A survey is given of the salient points which emerged from observations on energetic particles during the July 1966 proton flare event. These are: (a) relativistic electrons of energy 3 to 12 MeV were observed for the first time; (b) the ratio of protons to α particles at energy above 0.5 MeV/nucleon varies with time during the event; (c) low-energy protons and electrons ($E > 0.5$ MeV) are confined within a tube of force of the interplanetary magnetic field; (d) a bidirectional anisotropy in the stream of protons is associated with the Forbush decrease. (auth)

22833 SUMMARY ON LOW-ENERGY PARTICLE EVENTS IN THE IONOSPHERE ASSOCIATED WITH THE JULY 1966 PROTON FLARE EVENT. Dieminger, W. (Max-Planck-Institut, Landau, Ger.). Ann. IQSY (Int. Years Quiet Sun), 3: 462-5(1969).

During the proton flare event of July 1966, low-energy particles were observed directly and by their effects on the magnetosphere, on cosmic-ray intensities, on the ionosphere, and on geomagnetic activity. None of the effects observed differed significantly from those observed for normal geomagnetic storms, but it would be premature to make deductions from one solar event of this nature. (auth)

22834 GENERAL SUMMARY ON THE RESULTS OF THE FIRST PROTON FLARE PROJECT PERIOD, JULY 1966. Simon, P. (Meudon Observatory, France); Svestka, Z. Ann. IQSY (Int. Years Quiet Sun), 3: 469-99(1969).

A survey is given of all the material presented in the whole Proton Flare volume, picking out the salient points from each contribution, relating these, and indicating possible explanations of the phenomena observed. (auth)

22835 INDIUM, RUBIDIUM, AND CESIUM IN SUNSPOTS. Stellmacher, G. (Institut d'Astrophysique, Paris); Wiehr, E. Astrophys. Lett., 3: 91-3(Mar. 1969).

The abundances in In, Rb, and Cs were obtained from high-resolution sunspot spectra by comparison with nearby lines of Zr and Ti. Since the reference lines have nearly the same wavelength, equivalent width, and excitation states as the lines under investigation, influences of stray light and uncertainties in the sunspot model are largely avoided. The following relative abundances were obtained: $\log \epsilon_{In}/\epsilon_{Zr} = -1.15$, $\log \epsilon_{Rb}/\epsilon_{Zr} \leq 0.0$, and $\log \epsilon_{Cs}/\epsilon_{Ti} < -2.73$. For Cs one finds only very weak absorption features, at $\lambda \simeq 8521.2$ and 8943.5 Å, which cannot be satisfactorily identified. (auth)

22836 FIVE-MINUTE OSCILLATION OF THE SOLAR ATMOSPHERE. Stein, R. F.; Leibacher, J. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. Lett., 3: 95-6 (Mar. 1969).

The observations of Frazier, resolving the power spectrum of the solar oscillation into two harmonics, are used in a simple model of the oscillating region as a bounded isothermal layer to deduce a height and mean temperature of the oscillating region. (auth)

22837 THE FUTURE OF THE SUN. Roxburgh, I. W. (Queen Mary Coll., London). Advan. Sci., 25: 289-97(Mar. 1969).

The text of the Kelvin lecture delivered to the Dundee Meeting of the British Association for the Advancement of Science (Aug. 27, 1968) is reproduced. Present ideas on how the Sun will change in the future, and in particular the question of whether the Sun will explode, are outlined. It is stated that the possibility of a cataclysmic future for the Sun is suggested from observations of planetary nebulae. (UK)

22838 ROCKET SPECTROGRAPHIC OBSERVATIONS OF α VIRGINIS. Smith, Andrew M. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 156: 93-105(Apr. 1969).

Two spectrograms of α Vir (B1 V) in the wavelength interval $928 < \lambda < 1350$ Å and with 0.8 Å resolution were successfully recorded on a rocket flight June 1, 1967. The data revealed hydrogen Lyman absorption lines through Ly-ζ and, in addition, evidence for 128 absorption lines arising from the ground and low-lying states in ions of C, N, Si, S, Cl, Ti, V, Cr, and Fe. The results imply that strong line blanketing occurs at $\lambda < 1350$ Å. No interstellar absorption lines due to H_2 were observed; an upper limit for the mean number density of this molecule between the Earth and α Vir is 3.1×10^{-4} cm^{-3}. (auth)

22839 RELATIVE INTENSITIES OF SELECTED Si II MULTIPLETS IN THE SPECTRUM OF THE SUN AND ZETA. Jordan, Carole (Culham Lab., Abingdon, Eng.). Astrophys. J., 156: 49-57(Apr. 1969).

The relative intensities of five multiplets of Si II are calculated by assuming that the excited levels are populated only by collisional excitation from the ground term; these are compared with the values observed in the spectrum of the Sun and ZETA. The observed intensity of the multiplet at 1195 Å, relative to that at 1309 Å, is an order of magnitude weaker than calculated, while the observed intensity of the multiplet at 1817 A, relative to that at 1309 Å, is an order of magnitude stronger than calculated. It is suggested that the great strength of the latter multiplet is due to stepwise excitations via the metastable $3s3p^3\ {}^4P$ levels and that the collision strength for the transition $3s3p^2\ {}^4P_{5/2,3/2}-3s3p^2\ {}^2D_{5/2}$ is $\Omega \simeq 10$. A complete solution to these problems must await more accurate cross sections. (auth)

22840 POSSIBLE EMISSION OF POLARIZED MICROWAVE RADIATION FROM THE SOLAR HEMISPHERES. Kaufmann, Pierre; Matsuura, Oscar T.; Marques dos Santos, P. (Mackenzie Univ., Sao Paulo, Brazil). Astrophys. J., 156: 43-7(Apr. 1969).

A small, but qualitatively well-characterized effect in circular polarization of solar microwave radio emission close to the totality of an eclipse leads to the discussion of the possible emission of polarized radiation in the solar hemispheres; the polarization is right-handed in the southern and left-handed in the northern hemisphere. The polarized component of radiation seems to be due to a general solar magnetic field with the main contribution from the solar polar caps, where the magnetic-field configuration remains persistent and has a poloidal character. (auth)

22841 ON GRAVITY-COUPLED MAGNETOHYDRODYNAMIC WAVES IN THE SUN'S ATMOSPHERE. Howe, M. S. (Imperial Coll. of Science and Tech., London). Astrophys. J., 156: 27-41 (Apr. 1969).

This paper contributes to the theory of the intense heating of the solar chromosphere and corona which occurs above a height of about 1000 km. The efficiency of the sources of acoustic radiation within the convective zone appears hardly sufficient to account for all of this heating, and alternative mechanisms of mechanical wave generation made more powerful by the presence of a magnetic field are needed to explain chromospheric brightness in magnetically active regions. Lighthill proposes a mechanism involving the concept of "tongues of turbulence" which intermittently protrude above the convective zone and generate gravity waves in the stratified atmosphere, which at higher altitudes may be converted into magnetohydrodynamic waves. Furthermore, in regions of strong magnetic field (30 gauss, say) disturbances created by these tongues may be dragged clear of the convective zone and propagated along the magnetic-field lines. A property of such an Alfvén wave in a stratified medium is that the vertical component of the vorticity field is propagated without change along the lines of force, whereas horizontal components tend to be spread out. Under these circumstances it is desirable to investigate the manner in which the initially closed vortex loops are affected by the motion, in order to ensure that basic principles, which require the loops to remain closed, are not violated. Such a verification in terms of a simple model of a tongue of turbulence (Hill's spherical vortex) is presented. The effects of dissipation due to Joule heating of the atmosphere on the motion of the vortex wave is discussed, where it is estimated that a tongue of turbulence should have a diameter of the order of the granulation size if it is to escape into the upper chromosphere and contribute to the heating process. (auth)

22842 MAGNETO-KINEMATIC MODEL OF THE SOLAR CYCLE. Leighton, Robert B. (California Inst. of Tech., Pasadena). Astrophys. J., 156: 1-26(Apr. 1969).

A simple kinematical model of the solar cycle, based upon field amplification by the solar differential rotation, is presented. Numerical solutions of the model equations are found which are in close quantitative agreement with Spoerer's Law of Zones, Maunder's butterfly diagram, and the poleward migration of polar prominences. Fluctuations in eruption rate are introduced and are shown to produce fluctuations in period, amplitude, and relative phase and amplitude in the two solar hemispheres which agree closely with observed values. (auth)

22843 DIFFUSION MODEL AND INJECTION SPECTRA OF SOLAR-FLARE PROTONS. Miroshnichenko, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radiowave Propagation, Moscow). Bull. Astron. Inst. Czech., 20: 33-6(1969).

The diffusion model of the propagation of solar cosmic rays in interplanetary space is studied under the assumption that the coefficient of diffusion depends on the rigidity of the particles and the distance from the Sun. Using this model, the injection spectra are obtained for a number of flares from 1956 to 1967. A tendency was found towards the bend of the spectrum at transition to a region of small rigidities. The qualitative agreement between the spectra of nonrelativistic protons and electrons, causing x-ray and radiowave radiation of the flares, is pointed out. (auth)

22844 SOME COMMENTS ON THE LONG-TERM FORECASTS OF PROTON FLARES. Obridko, V. N. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 37-8(1969).

It is shown that proton complexes far away from one another and, in particular, isolated, give a much smaller number of proton flares than near complexes. This result may be useful for long-term forecasting of proton flares. (auth)

22845 EAST–WEST ASYMMETRY IN THE SOLAR WIND VELOCITY. Siscoe, G. L.; Goldstein, B.; Lazarus, A. J. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 74: 1759-62(Apr. 1, 1969).

An east–west asymmetry may exist in the solar wind velocity due to the action of a well-known mechanism, namely, the influence of the solar rotation on the interaction between fast and slow streams. The mechanism predicts that fast streams tend to come from the west and slow ones from the east with respect to the average solar wind direction. It is noted that if there is a correlation between density and velocity, a measurement of the average azimuthal wind component is not sufficient to determine the angular momentum flux. Experimental evidence from Pioneer 6 indicates that about 50% of the east–west variations in flow direction with periods around 4 days (the largest period studied) may be due to the fast stream–slow stream interaction. The percentage decreases for shorter periods. (auth)

22846 SOLAR DIFFERENTIAL ROTATION AND OBLATENESS. Clark, Alfred Jr.; Thomas, John H.; Clark, Patricia Andre (Univ. of Rochester, N. Y.). Science, 164: 290-1(Apr. 18, 1969).

An investigation of the time development of differential rotation produced by the solar wind torque indicates that the Sun has a rapidly rotating core. (auth)

22847 SOME REGULARITIES IN THE DISTRIBUTION OF LARGE-SCALE MAGNETIC FIELDS ON THE SUN. Bumba, V. (Astronomical Inst., Ondrejov, Czech.); Howard, R.; Kopecky, M.; Kuklin, G. V. Bull. Astron. Inst. Czech., 20: 18-21(1969).

An attempt to clarify the regularity of distribution of solar magnetic fields with the aid of an autocorrelation analysis of seven magnetic synoptic charts shows that these regularities consist of maxima spaced apart about 35° in longitude. Also noted is a strong maximum at about 60°. (auth)

Galaxies

Refer also to abstracts 22766 and 23062.

22848 OBSERVATIONS OF THE NUCLEUS OF THE RADIO GALAXY M82. van den Bergh, Sidney (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 156: L19-20(Apr. 1969).

An infrared photograph of M82 = NGC 3032 shows that this galaxy is an edge-on, late-type spiral with a well-defined (but nonstellar) nucleus. The spectrum of this nucleus shows that M82 is not a Seyfert galaxy. (auth)

22849 A MEASUREMENT OF THE GALACTIC MAGNETIC FIELD USING THE PULSATING RADIO SOURCE PSR 0833-45. Ekers, R. D.; Lequeux, J.; Moffet, A. T.; Seielstad, G. A. (California Inst. of Tech., Pasadena). Astrophys. J., 156: L21-5(Apr. 1969).

The radiation from PSR 0833−45 is strongly linearly polarized. Measurements at 21, 18, and 13 cm show a rotation measure of $+33 \pm 5$ rad m^{-2}. Combined with the published value of the dispersion measure, this yields a mean value of 0.73 ± 0.13 μG for the longitudinal component of the galactic magnetic field along the inner face of the Orion arm. (auth)

22850 THE PECULIAR GALAXY NGC 4194. Demoulin, Marie-Helene (Univ. of California, San Diego). Astrophys. J., 156: 325-8(Apr. 1969).

The galaxy NGC 4194 has an emission-line spectrum showing the presence of highly excited gas. The line [O I] λ6300 appears not only in the nucleus, but also in the very bright central region 1400 pc in diameter. The velocity gradients in the excited gas have been interpreted as rotation providing a value for the mass of a few times 10^9 $M_{\odot}$. The uncertainties of this value may be large; they are due to the possible presence of noncircular motions and the impossibility of determining the orientation of the galaxy. In many respects NGC 4194 has a strong similarity to NGC 7714, studied previously. (auth)

22851 TRANSIENT NATURE OF THE GALACTIC HALO. Brunstein, K.; Lal, S. (Univ. of Denver). Phys. Lett., 28A: 576-7(Jan. 27, 1969).

A lower limit to the age of the galactic halo is obtained by comparing cosmic-ray positron measurements with theoretical calculations. (auth)

Cosmology

Refer also to abstracts 22942 and 22945.

22852 (NP-17833) A PROGRAM FOR DETERMINATION OF ABSORPTION IN COSMOLOGICAL IMPORTANT AREAS. Report No. 26. Solheim, Jan-Erik; Stabell, Rolf (Oslo Univ. (Norway). Institutt for Teoretisk Astrofysikk). 1968. 11p. Dep.

Discrete absorbing clouds at high galactic latitudes may necessitate an individual correction to the magnitudes of extragalactic objects. The implications of this correction for cosmological tests are discussed briefly and a program for the determination of a minimum value of the absorption in cosmologically important areas is outlined. (auth)

22853 (ORNL-tr-1833) RELATIVE STELLAR ABUNDANCE AND ORIGIN OF THE CHEMICAL ELEMENTS. Unsoeld, A. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Z. Phys., 202: 13-21(1967). 10p. Dep. CFSTI.

An abstract of the original German paper appeared in NSA 21: 39715. (L.M.T.)

22854 PERTURBATION OF COSMOLOGICAL MODELS. Johri, V. B. (Univ. of Gorakhpur, India). Astrophys. Lett., 3: 65-6(Mar. 1969).

The tetrad formalism is used to examine the growth of density perturbation of both isotropic and anisotropic dust cosmological models. The conservation of angular momentum in an expanding Universe is also considered. (auth)

22855 ROCKET INFRARED ASTRONOMY: ON THE TRACK OF THE BIG BANG. McNutt, Douglas P. (Naval Research Lab., Washington, D. C.). Astronaut. Aeronaut., 7: 44-9(Mar. 1969).

Recent results on irradiation from rocket experiments bearing on cosmological theory are reviewed. Astronomical interest in the long-wavelength ir centers around the big-bang hypothesis of relativistic cosmology, which has the Universe originating as a dense cloud of matter that exploded about 10^{10} yr ago. It appears that the most plausible sources of observed discrete ir emission are galaxies. While it is difficult to determine the processes by which the high luminosities are produced in the ir region of the spectrum, it is rather simple, from energy considerations, to fit these sources into models of massive starlike objects whose other evolutionary stages include the Seyfert galaxies and quasars. It is emphasized, however, that the present data represent only 50 sec of observation from a first-generation rocket instrument. Further rocket observations in the same wavelength band and at longer wavelengths are clearly needed before any firm conclusions can be reached. Ground-based observations of the possible sources through the atmospheric windows at 10 and 20 μ and at millimeter wavelengths will also be extremely valuable. (BBB)

22856 RADIATIONS OF THE COSMOS AND LIFE. Cartier, Maurice. Aeronaut. Astronaut., No. 5, 49-55(1968). (In French).

Studies ranging from the simplest interactions of radiation with matter to the most complex are examined. The studies are based on the effects of x rays with rapidly reproducing organisms, particularly Escherichia coli. Mathematical analysis of simple effects is first introduced. A cataloguing of various types of solar eruptions is given to classify the types of radiation which may be expected in trips through space. Problems become more complex in this regard as time passes: for example, the idea of a localization of the source of galactic radiation is weakened, and properties of radiation acquired by transmittal through the galaxy offer new means for further study of the Universe, especially the movement of matter in galactic space. (BBB)

22857 COSMOLOGY AND OBSERVATIONS. II. Godart, O. (Univ., Louvain, Belg.). Ann. Soc. Sci. Brux. Ser. I, 82: 269-305(Dec. 31, 1968). (In French).

Observations are reported on the $m-z$ diagram and enumeration, the three grand periods of the Universe, the beginning of the Universe, the formation of galaxies, and the age of the Universe. The various cosmological models are compared. A model is proposed which assumes a considerable evolution beginning with the breaking down of the protogalaxy, characterized principally by a decrease of the intrinsic luminosity. Moreover, it is assumed that during the formation of inhomogeneities, the values of the small ψ parameters were far the most frequent and, in particular, our Galaxy has a ψ parameter of the order of 30′ to 1°. An age of the Galaxy much longer should be considered. (J.S.R.)

22858 THE HOYLE-FOWLER MODEL OF QUASI-STELLAR OBJECTS. Barnothy, J. M. Astrophys. J., 156: 373-6(Apr. 1969).

The huge mass and small diameter of the astronomical objects proposed by Hoyle and Fowler as models of QSOs make them excellent gravitational lenses. About 10^5 such objects within 100-Mpc distance would produce several thousand well-visible, ring- or crescent-shaped images of 15″ to 160″ apparent size. The circumstance that no such conspicuous objects were yet observed renders Hoyle and Fowler's QSO model questionable. (auth)

22859 DISCRETE SOURCE MODELS TO EXPLAIN THE MICROWAVE BACKGROUND RADIATION. Wolfe, A. M.; Burbidge, G. R. (Univ. of California, San Diego, La Jolla). Astrophys. J., 156: 345-71(Apr. 1969).

Using the homogeneous and isotropic, spatially flat Friedmann and steady-state world models the background radiation generated by a cosmic population of intense sources is considered. Under certain assumptions in each model the observed microwave background can be produced, and only observations at a wavelength of ~350 μ will be able to distinguish between the source and black-body background spectra. The source backgrounds are compatible with the large degree of microwave isotropy measured to date, but small-scale anisotropies might be resolvable in the source backgrounds at wavelengths near and shortward of the spectral peak. The required sources must be very luminous (10^{45} to 10^{47} ergs sec^{-1}) in the millimeter bands, and they must have spatial densities not less than 1% of the density of galaxies. Furthermore, the sources must have relatively weak radio components. The source requirements are compared with objects that are intense in the infrared and millimeter bands (e.g., Seyfert nuclei and QSOs), and it is shown that radio-quiet QSOs might be the most suitable objects. (auth)

22860 ORIGIN OF GALAXIES AND THEIR NUCLEI: FRAGMENTS OF AN EXPLOSIVE UNIVERSE. Fouchet, Jacques. Sci. Progr.-Nature, No. 3405, 1-6(Jan. 1969). (In French).

The phenomena which seem to depend on the activity of the galactic core are outlined. The age and evolution of galaxies according to the centrifuge theory are considered. The characteristics of quasars and their variations are summarized. The hypotheses on the nature of quasars are discussed. The explanations proposed for the origin of the extraordinary energy of quasars are summarized. (J.S.R.)

22861 A NOTE ON THE ROLE OF ZERO-POINT ENERGY IN EVOLUTIONARY COSMOLOGY. Kumar, N. (Univ. of

British Columbia, Vancouver). J. Phys., A (London), 2: 210-14 (Mar. 1969).

Following a suggestion originally due to McCrea (1951), a physical vacuum is regarded as the ground state of a certain quantized field obeying Bose statistics. Under certain assumptions regarding the physical nature of the zero-point energy (assumed to be essentially positive) associated with the Bose field, the latter is found to result in an effectively negative kinematic pressure p having a functional dependence of the form $p \propto G^{-4}$, where G is the curvature of space. This leads naturally to an oscillating isotropic model of the Universe without singularity, of the type treated in detail by Pachner (1965). In effect, the purely mathematical artifice of assuming negative pressure is given a physical basis in terms of the zero-point energy considerations. (auth) (UK)

22862 HILBERT SPACE DESCRIPTION FOR THE GRAVITATIONAL FIELD. Carmeli, M. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Lett., 28A: 683-4(Feb. 24, 1969).

A Hilbert space defined over the special unitary group of order two, SU_2, is constructed to describe the Weyl tensor of the gravitational field. (auth)

22863 A COSMOLOGICAL MODEL IN WHICH "SINGULARITY" DOES NOT REQUIRE A "MATTER SINGULARITY". Shepley, L. C. (Univ. of Texas, Austin). Phys. Lett., 28A: 695-6(Feb. 24, 1969).

The type V-homogeneous, relativistic, dust-filled model is presented in which there is a singular region which is not accompanied by a matter singularity. This example throws light on the physical significance of singularities in general relativity. (auth)

Planetary Phenomena

22864 JOVIAN LINEAR POLARIZATION AT 6-CM WAVELENGTH. Whiteoak, J. B.; Gardner, F. F.; Morris, D. (Commonwealth Scientific and Industrial Research Organization, Sydney). Astrophys. Lett., 3: 81-4(Mar. 1969).

Measurements of linear polarization at 6 cm have permitted an accurate determination of the rotation period associated with the centimeter radiation from Jupiter. The period of 09 hr 55 min 29.69 sec ± 0.05 sec agrees well with the most recently determined value at decameter wavelengths of 09 hr 55 min 29.70 sec ± 0.04 sec. The polarized radiation is more highly beamed at 6 cm than at wavelengths of 11 cm and longer, and the maximum intensity is displaced from the magnetic equatorial plane. The beamed radiation appears to be considerably more polarized than the general nonthermal radiation from the planet. (auth)

22865 IO, A JOVIAN UNIPOLAR INDUCTOR. Goldreich, Peter (California Inst. of Tech., Pasadena); Lynden-Bell, Donald. Astrophys. J., 156: 59-78(Apr. 1969).

It is shown that Io may be considered to be a unipolar generator which develops an emf of 7×10^5 volts across its radial diameter (as seen from a coordinate frame fixed to Jupiter). This voltage difference is transmitted along the magnetic flux tube which passes through Io. The induced charge separation on the surface of the flux tube causes the plasma within it to rotate with Io's orbital angular velocity. A current of about 10^6 amp is driven across each foot of the flux tube in the Jovian ionosphere. The current flows up along the half-surface of the flux tube which faces Jupiter, crosses the magnetic field in Io, and then flows down along the opposite half of the flux tube's surface. Because the number density of charge carriers in the magnetosphere is low ($n = 0.5\ cm^{-3}$) the current must be carried by keV electrons which are electrostatically accelerated at Io and at the top of Jupiter's ionosphere. It is argued that beam instabilities in the current sheets are responsible for the Io-induced decametric bursts. The geometry of the beaming of the bursts strongly suggests coherent cyclotron radiation as the emission mechanism. In addition, one is led to predict that Europa should modulate decametric bursts whose maximum frequencies are below 8 Mc. Bigg was the first to demonstrate that the position of Io in its orbit was strongly correlated with the reception of Jovian decametric bursts. Previously it had been established that the detection of the bursts was influenced by the position of Jupiter's magnetic dipole. The aim is to explain the origin of Io's great influence. (auth)

22866 THE RATIO OF DEUTERIUM TO HYDROGEN IN THE VENUS ATMOSPHERE. McElroy, Michael B.; Hunten, Donald M. (Kitt Peak National Observatory, Tucson, Ariz.). J. Geophys. Res., 74: 1720-39(Apr. 1, 1969).

Interpretations of the Lyman-α data from Mariner 5 are critically discussed, in view of the finding by the experimenters that a normal exosphere of atomic hydrogen does not fit. A two-component exosphere appears to be required, but the second component cannot be H_2, or H at a different temperature. Deuterium is a much better possibility, but the D/H ratio at the base of the exosphere must be about 10. It is shown that the ratio can be reconciled with all available observations or upper limits. Transport through the thermosphere can increase the D/H ratio as much as a factor of 100: the ratio in the lower atmosphere could then be 0.1. This transport problem is solved in detail, with the eddy diffusion coefficient as a parameter. Isotopic fractionation by thermal escape is discussed, and Venus is shown to be an especially favorable case for this process. The required initial supply of H_2O is less than 0.1% of the terrestrial value. This amount can be postulated ad hoc, or the remainder plausibly can be dissipated in an initial phase, an atmosphere dominated by water vapor, in which escape of H should have been very fast. It is concluded that a high D/H ratio on Venus is a serious possibility. (auth)

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Refer also to abstracts 21696, 21702, 22049, 23004, 23148, 23264, 23295, 23300, and 23743.

22867 (AD-675287) ATOMIC COLLISION PROCESSES RELATING TO THE IONOSPHERE. Final Report, June 1, 1958–August 31, 1968. Phelps, A. V.; Chantry, P. J. (Westinghouse Research Labs., Pittsburgh, Pa.). Sept. 20, 1968. Contract Nonr-2584(00). 40p. CFSTI.

The more important results obtained are summarized and abstracts of the technical reports published under the contract are included. The published results include the experimental discovery of resonances in the elastic scattering cross sections of atoms and molecules, studies of the role of resonances in the determination of vibrational and electronic excitation cross sections and of cross sections for negative-ion formation, and determinations of elastic and inelastic scattering cross sections for electrons in various gases such as N_2, O_2, CO_2, and H_2O. Recent unpublished results concerned with electron attachment in O_3 and N_2O and with the development of a new technique for the measurement of inelastic scattering cross sections are discussed. (auth) (USGRDR)

22868 (ANL-Trans-723) ENERGY DISTRIBUTION OF SECONDARY ELECTRONS RELEASED BY PROTONS IN GASES. Blauth, Erich. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Z. Phys., 147: 228-40(1957). 19p. Dep. CFSTI.

Spectra of secondary electrons released by 49-, 11.8-, and 8.8-keV protons in gases at an angle of 54.5° were recorded. The 49-keV curves show at electron energies of approximately 20 to 30 eV an arch that can be explained by the energy–angle correlation for a secondary electron at rest before the impact. The steep decline of the spectra toward higher electron energies agrees qualitatively with a theory by Fermi. For a certain energy region, the relationship $f(U) \sim U^{-\beta}$ was obtained. The exponent was found to have values from approximately 3 to more than 4. The maximum energy transfer (ΔT_{max}) of a proton to a secondary electron calculated according to the energy-and-impulse law was compared with points at which the experimental spectra begins a steep ascent. These points can be correlated with the proton energy and the electron arrangement in the target atom. Above ΔT_{max} the 11.8- and 8.8-keV spectra show, in particular for H_2, N_2, and Kr, a renewed ascent; for H_2 a second maximum occurs at approximately 400 eV. (auth)

22869 (N-68-32284) SHOCK-TUBE STUDIES OF N^+ AND O^+ RECOMBINATION RADIATION IN THE VACUUM ULTRAVIOLET. Final Report. Marrone, Paul V.; Wurster, Walter H.; Stratton, John E. (Cornell Aeronautical Lab., Inc., Buffalo, N. Y.). June 1968. Contract NASr-119. 105p. (NASA-CR-96235; CAL-AG-1729-A-7). CFSTI.

Spectrally resolved vacuum-uv radiation measurements of the continuum arising from the recombination of electrons with N^+ and O^+ ions were made in a high-purity shock tube. Mixtures of neon and nitrogen or oxygen were used. The radiation was observed behind the reflected shock wave at 11,000 to 13,000°K. Since this radiation occurs at wavelengths less than 1100 Å, the use of windows is precluded. An explosively driven windowless plunger couples the shock tube to a vacuum-uv spectrometer with three bare stainless steel photomultiplier detectors. The plunger-detector system, the purity level of the gas handling system, the long ionization relaxation times of N_2 and O_2 heavily diluted with neon, and the effects of nonequilibrium on the state of the gas are discussed. The shocked gas in the experiments ranged from optically thin to black-body conditions. Photoionization cross sections for both N and O were obtained; they compare favorably with theoretical calculations. (auth) (STAR)

22870 ELECTRON EXCITATION OF THE FIRST POSITIVE BANDS OF N_2 AND OF THE FIRST NEGATIVE AND MEINEL BANDS OF N_2^+. Stanton, Paul N.; St. John, Robert M. (Univ. of Oklahoma, Norman). J. Opt. Soc. Amer., 59: 252-60(Mar. 1969).

Absolute optical cross sections for the excitation from the $X^2\Sigma_g^+$ ground state of N_2 by electron impact have been measured for 39 N_2 first positive bands ($B^3\Pi_g - A^3\Sigma_u^+$), 12 N_2^+ first negative bands ($B^2\Sigma_u - X^2\Sigma_g^+$), and 10 N_2^+ Meinel bands ($A^2\Pi_u - X^2\Sigma_g^+$). Relative excitation functions are presented for N_2 first negative bands with v' values from 0 through 9 for 0 to 50 eV, for the (0,0) and (1,0) N_2^+ first negative bands for 0 to 450 eV, and for the (3,0) and (4,1) N_2^+ Meinel bands for 0 to 450 eV. The first-positive excitation functions exhibit sharp peaks at 10 to 12 eV and at 14 to 15 eV and exhibit an S-shaped change in slope about midway between onset and the maximum of the first sharp peak. The first negative and Meinel excitation functions have broad maxima at about 120 and 100 eV. (auth)

22871 RESONANCE SCATTERING OF ELECTRONS BY DIATOMIC MOLECULES. Hasted, J. B.; Awan, A. M. (University Coll., London). J. Phys., B (London), 2: 367-80(Mar. 1969).

Elastic and inelastic channel measurements in transmission are reported for the resonance scattering of electrons by N_2, CO, O_2, and NO; their interpretation is discussed quantitatively in terms of the compound-state model and of the first reflection model. In the case of O_2 and NO, the resonance scattering probably arises from the ground state of the negative ion. For small electron energy losses (excitation of low vibrational quantum numbers) the transmission technique suffers from interference from elastically scattered electrons. A discussion is included of a number of features of electron momentum analysis in the 127° cylindrical selector, including field penetration broadening and background ghosts. (auth) (UK)

22872 IONIZATION OF EXCITED H ATOMS BY COLLISIONS WITH H, Li, OR Na. Lodge, J. G. (Univ. of Sydney). J. Phys., B (London), 2: 322-32(Mar. 1969).

The hydrogen ionization collision $H_n - M_B$, where H_n is a hydrogen atom in state n and M_B is the atom H, Li, or Na and may be left in any final state, is considered. The Born approximation is used, together with an approximation to the sum over all final states of M_B. Initially the ionized electron is treated in the plane-wave approximation and later the continuum Coulomb function is used. The results are given in the energy range 20 to 150 keV and where possible compared with other theoretical and experimental results. (auth) (UK)

22873 NEW FORBIDDEN LINES IN THE L EMISSION SPECTRUM OF Gd. Deodhar, G. B.; Varma, P. P. (Allahabad Univ., India). J. Phys., B (London), 2: 410-12(Mar. 1969).

A systematic study of the L-emission spectrum of gadolinium revealed the existence of the quadrupole lines λλ1502.01 and 1616.22 x.u. corresponding to the transitions $L_IN_{IV,V}$ and $L_{II}N_{III}$, respectively, and the octupole line $L_{II}M_V$ (λ1834.77 x.u.). The presence of the dipole line $L_{II}O_I(\gamma_8)$ and of the quadrupole line corresponding to the transition $L_IO_{IV,V}$, reported for this element by Sakellaridis (1953 and 1955), was confirmed. The discrepancy between the wavelength values reported for the dipole line $L_{III}O_I(\beta_7)$ by Coster and Sakellaridis was also removed. (auth) (UK)

22874 NEW DIAGRAM LINES IN THE L EMISSION SPECTRUM OF THULIUM. III. α REGION. Nigam, A. N.; Garg, K. B. (Univ. of Rajasthan, Jaipur, India). J. Phys., B (London), 2: 419-21(Mar. 1969).

A 40-cm and a 20-cm curved mica crystal spectrograph of the transmission type were used to investigate the α region of the L-emission spectrum of thulium. Three new diagram lines at 1583.4, 1600.9, and 1886.8 x.u. were reported for the first time. The first line was assigned to the forbidden transition L_IM_I, whereas the remaining two corresponded to the quadrupole transitions $L_{II}M_{III}(\beta_{17})$ and $L_{III}M_{II}(t)$ respectively. The measurements on the previously known diagram lines in the region under study were compared with those of earlier workers. (auth) (UK)

22875 RELATIVISTIC AND EXCHANGE EFFECTS IN ELECTRON SCATTERING FROM MERCURY. Walker, D. W. (Univ. of Melbourne, Victoria). J. Phys., B (London), 2: 356-66(Mar. 1969).

Differential cross sections and spin polarizations for 3.5- to 500-eV electrons scattered from mercury were calculated by numerical solution of the relativistic Hartree–Fock equations, thus including the effect of exchange but ignoring distortion of the atom and correlation effects. At the upper end of the energy range the inclusion of exchange produces small but significant changes that bring the results into very good agreement with experiment. At lower energies some discrepancies appear, but even at 3.5 eV good qualitative agreement is obtained. (auth) (UK)

22876 QUANTUM THEORY OF DISSIPATIVE SYSTEMS AND SCATTERING PROCESSES. Prigogine, I. (Univ. Libre, Brussels. Univ. of Texas, Austin). pp 99-129 of Fast Reactions and Primary Processes in Chemical Kinetics. Claesson, Stig (ed.). New York, John Wiley and Sons, Inc., 1968.

From 5th Nobel Symposium, Lidingoe, Sweden. See CONF-670844.

The usual T-matrix theory for scattering processes is briefly summarized. Conceptual and computational problems arise when the transition between the initial state i and the final state f considered may be achieved through different types of transition involving energy conservation in an intermediate step. This is illustrated by three-body collisions and resonance scattering. An alternative approach based on the density-matrix formalism is presented. To illustrate the procedure used, the interaction between matter and radiation is considered in somewhat more detail. In this approach the emphasis is on transition probabilities (and not on transition amplitudes). To lowest approximation (Pauli equation) one obtains a kinetic equation containing transition probabilities, which may also easily be derived from the Born approximation of the T-matrix theory. It is indicated how higher-order kinetic equations may be constructed in such a way as to isolate the different physical processes involved and to obtain the corresponding transition probabilities. This is only possible if a clear cut distinction between real and virtual processes is introduced not only for the "in" and "out" states but also for states having a finite lifetime (such as excited atomic levels or unstable particles). This is done using the "quasiparticle" approach. The essential point is that a generalized transformation theory may be formulated for dissipative systems with a continuous spectrum. This brings the kinetic equation into a form very similar to the lowest-order Pauli approximation but involving new higher-order transition probabilities. Moreover this transformation introduces new definitions of quantum mechanical operators and quantum mechanical states. The transformation is chosen in such a way as to give to the entropy the usual simple form for independent entities. This method is applied to spontaneous emission and resonance scattering and the relation with the usual approach is discussed. In this approach systems with finite lifetime have still well defined energy levels (depending in general on all occupation numbers) but they depend now on the dissipative properties of the system. On the other hand each state of such systems is no more characterized by a wave function but by a well defined density matrix involving (in the representation of the unperturbed Hamiltonian) both diagonal and off-diagonal elements. This theory reduces to well known results when applied to the ground state or when dissipative effects are neglected. It seems to lead to a generalization of the quantum mechanical formalism to include states with a finite lifetime. (auth)

22877 ON THE ORDER OF ACCURACY OF THE BORN–OPPENHEIMER APPROXIMATION FOR MOLECULAR COLLISION STATES. Gerber, R. B. (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 309: 221-4(Mar. 25, 1969).

The accuracy of the approximation separating nuclear and electronic motions in molecular systems is examined for atom–atom collisions. As in the study of Born & Oppenheimer of the analogous problem for bound molecular states, the parameter $\gamma = (m/M)^{1/4}$ (m, M are respectively the electronic mass and the mean mass of the nuclei) is used for the classification of the order of magnitude of the various quantities involved. The fundamental observables of collision theory, whose accuracy is of central interest in the present context, are the transition probabilities. By developing the integral equation for the transition matrix in powers of λ, and using an asymptotic expansion for the electronic Hamiltonian and energy in terms of the inverse of the internuclear distance, it is shown that the adiabatic approximation yields a T-matrix (hence also transition amplitudes) correct up to the order of λ^3. A similar treatment is applied to the Lippmann–Schwinger equation for the total wave function and leads to the conclusion that the adiabatic approximation for the latter is correct up to the order of λ^2. These results are subject to the condition that the electronic energy is not degenerate. The conclusions can be generalized to cover collisions between two groups of atoms. (auth) (UK)

22878 MATRIX FACTORIZATIONS FOR THE COULOMB INTERACTION BETWEEN ELECTRONS IN ATOMS. Judd, B. R. (Johns Hopkins Univ., Baltimore); Armstrong, L. Jr. Proc. Roy. Soc. (London), Ser. A, 309: 185-94(Mar. 25, 1969).

In contrast to what would be expected from a straightforward application of the Wigner–Eckart theorem, a simple factorization can often be made of matrix elements of operators that represent parts of the Coulomb interaction between f electrons in atoms. This property, which was discovered by Racah, is explained by using as basic states those in which the electrons are divided into two classes according to their spin orientation. The two collections of electrons are coupled through the irreducible representations of the group G_2 to which they belong, and this permits many of Racah's proportionality constants to be related to isoscalar factors. The analogous factorizations that Feneuille found for the configurations $(s + d)^N$ are also discussed. (auth) (UK)

22879 GROUND LEVEL OF SUPER HEAVY ATOMS. Rein, Dieter (Univ., Wuerzburg, Ger.). Z. Phys., 221: 423-30(1969). (In German).

A bound relativistic electron in a Coulomb field with charge numbers greater than 137 is considered. By careful examination of the self-adjointness property of the Hamiltonian the energy eigenvalues are determined; they depend on a parameter that can be interpreted as a cut-off radius of the potential leading to quantitative predictions of the energy of the spectrum, especially of the lowest state. (auth)

22880 SECONDARY ELECTRON EMISSION FROM A MOLYBDENUM TARGET BOMBARDED BY POSITIVE AND NEGATIVE IONS OF THE SAME ELEMENT. Perdrix, M.; Paletto, S.; Goutte, R.; Guillaud, C. (Institut National de Sciences Appliquees, Villeurbanne, France). J. Phys., D (London), 2: 441-6(Mar. 1969). (In French).

The variation of the apparent coefficient of secondary electron emission of molybdenum bombarded by Cl^+, Cl^-, O^+, O^-, H^+ and H^- ions was determined as a function of the cleanliness of the surface and the energy and incidence of the ions. These measurements, performed at a pressure lower than 1 ntorr, show that the kinetic emission is the same in the case of positive and negative ions of the same element, in agreement with the theory of Parilis and Kishinievskii. The high value of the apparent emission under bombardment by H^- ions is interpreted by taking account of the process of detachment. (auth) (UK)

22881 K^- MESIC X-RAYS FROM LIGHT NUCLEI. Rook, J. R. (Nuclear Physics Lab., Oxford). Nucl. Phys., B9: 441-6 (1969).

The K^- mesic X-ray yields from ^7Li, ^9Be, B and ^{12}C have recently been measured. Here these data are analyzed in terms of the competing Auger, X-ray and nuclear absorption rates. It is shown that the simple model involving decay solely by circular orbits does not agree with the experimental data but a good measure of agreement can be obtained by neglecting Auger transitions and assuming that only a proportion of the mesons decay by circular orbits. Unfortunately these postulates are not unique in giving agreement with the experimental results. (auth)

22882 METASTABLE SPECIES PRODUCED BY ELECTRON EXCITATION OF N_2, H_2, N_2O, AND CO_2. Clampitt, R.; Newton, Amos S. (Univ. of California, Berkeley). J. Chem. Phys., 50: 1997-2001(Mar. 1, 1969).

A molecular beam is crossed by an electron beam to produce metastable molecules and fragments, which are detected by electron ejection from a Cs_3Sb cathode in a chamber operating at ultrahigh vacuum. Excitation functions for the production of H_2 $(c^3\Pi_u)$ molecules and of photons from H_2 are reported. The time-of-flight distribution of the slow group of H (2S) atoms from H_2 has been measured, and this differs from a previously reported distribution. Threshold-energy and kinetic-energy measurements have been made on the electronically excited fragments known to be produced in the dissociative excitation of CO_2 and N_2O. It is postulated that in CO_2 the initial products are CO $(a^3\Pi)$ and O^-. A new excitation curve for the $E^3\Sigma_g^+$ state of N_2 was determined. (auth)

22883 THE DECAY OF THE METASTABLE 2 ^1S STATE OF HELIUM IN A DISCHARGE. Ionikh, Yu. Z.; Frish, S. E. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 345-6(Oct. 1968).

Translated from Opt. Spektrosk., 25: 615-17(Oct. 1968).

Optical pumping of the discharge through the 2^1S-2^1P transition was used to study the relative population of the 2^1S level in the positive column of a glow discharge in He. Measurements of the dependence of the 2^1S population on the discharge current are compared with calculations based on the assumption that 2^1S decay is caused only by diffusion of atoms to the wall and with calculations including decay by collision with electrons. From the comparison it is concluded that the destruction of atoms in the 2^1S state by electrons plays an important role in the equilibrium of this level. (A.G.W.)

22884 A MEASUREMENT AND ANALYSIS OF OPTICAL EMISSIONS RESULTING FROM 20- TO 100-keV PROTON–NITROGEN COLLISIONS. Gardiner, Harold Arthur Birk. Logan, Utah, Utah State Univ., 1968. 183p.

Thesis.

Absolute cross sections for excitation of the N_2^+ first negative $(B^2\Sigma_u^+ \rightarrow X^2\Sigma_g^+)$ bands in collisions of 20- to 100-keV protons with N_2 have been measured under single-collision conditions. The cross sections are found to extrapolate very well to recent electron-impact data at proton energies above 550 keV. On the basis of a charge-exchange model, which predicted the observed variation of intensity with pressure, emission cross sections for the (0,0) λ3914 Å N_2^+ first negative band and the (0,2) λ3805 Å N_2 second positive band were obtained for hydrogen-atom impact and the sum of the cross sections for electron capture and loss were found for hydrogenic particles traversing N_2. The latter cross sections are in good agreement with those measured by charge-collection methods. An upper limit of 4×10^{-20} cm^2 has been established for the cross section for 100-keV proton-impact excitation of the second positive band. A critical analysis shows that the intensity-versus-pressure curve for this band provides a sensitive means of detecting secondary processes in this beam experiment. Cross sections for production of $\underline{H}_\beta$ radiation, determined from observations made at a point 30.5 cm from the collision chamber entrance, were found to be more than a factor of three larger than those reported by previous investigators. The cross section for collisional quenching of a 100-keV hydrogen atom from the $\underline{n} = \underline{4}$ level was estimated at 3×10^{-16} cm^2. (Disser. Abstr.)

22885 ENERGY LOSS OF ALPHA PARTICLES, PROTONS, AND ELECTRONS IN MATTER. Walsh, Phillip Joe. Chapel Hill, N. C., Univ. of North Carolina, 1968. 116p.

Thesis.

By assuming a simple hydrogen-like charge distribution for the atoms of a stopping material, the atomic stopping cross sections of hydrogen, helium, lithium, and carbon for protons are calculated. The results for hydrogen agree with experimental data for proton energies as low as 35 keV and the results for lithium, helium, and carbon agree with experiment for proton energies as low as about 100 keV. The theory is compared to other theories in the light of their regions of validity, and the dependence of the various stopping-power expressions on the charge of the penetrating ion is discussed. Experimental data are given for alpha particles penetrating acetylene, ethylene, and propane, and ratios of alpha-particle to proton stopping cross sections in air, nitrogen, acetylene, methane, and ethylene are presented for a proton energy range of 80 to 500 keV. The results suggest that such ratios may depend upon a number of factors including the atomic number of the absorbing material and the presence of chemical bonds. A Si(Li) solid-state spectrometer is employed to measure the most probable energy loss of 972-, 626-, and 365-keV electrons in aluminum, polyethylene, mylar, and mica. The results agree with the Landau theory except for the 972-keV electrons where the maximum range of the electrons is roughly equal to the depletion depth of the semiconductor detector. (Disser. Abstr.)

22886 POLARIZATION OF LYMAN ALPHA RADIATION FROM ION–ATOM COLLISIONS. Gaily, T. Dean. Seattle, Univ. of Washington, 1968. 124p.

Thesis.

Polarization of Lyman-alpha radiation from proton and deuteron charge-transfer collisions with rare gases has been measured over an energy range of 0.6 to 15.0 keV. These results, previously published, are reviewed and analyzed. Emission cross sections as well as polarization of Lyman-alpha radiation from H^+ and H_2^+ collisions with ground state hydrogen atoms have also been determined for projectile energies from 1.0 to 6.0 keV. This measurement used a crossed atomic beam technique wherein a modulated beam of hydrogen atoms from a thermal dissociation source was crossed by a beam of monoenergetic positive ions. Lyman-alpha radiation from the collisionally excited atoms was detected by an ultraviolet-sensitive photomultiplier tube together with a molecular oxygen optical filter. As a part of the experimental program the optical absorption characteristics of the oxygen filter in the neighborhood of Lyman-alpha were investigated with results that were not predicted from an extension of earlier work. The emission cross sections were normalized to the previously measured proton–H_2 reaction and the polarization fraction was deduced from the measured angular dependence of the Lyman-alpha radiation. Results of the proton projectile measurement are in rough qualitative agreement with a previous experimental investigation but both measurements differ somewhat from a recent theoretical prediction. Neither experimental results nor theoretical predictions are available for comparison in the case of the H_2^+ projectile measurement. (Disser. Abstr.)

22887 CROSS SECTIONS FOR THE EXCITATION OF THE K SERIES OF ARGON BY ELECTRON COLLISION. Dolgov-Saveiev, G. G.; Panchenko, V. E. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 270-2(Oct. 1968).

Translated from Opt. Spektrosk., 25: 484-7(Oct. 1968).

The excitation cross section of the K series of argon in the gaseous state was investigated as a function of the energy of electrons in the 3- to 16-keV range by measuring the total intensity of that series. (auth)

22888 CALCULATION OF HARTREE–FOCK ATOMIC WAVE FUNCTIONS AND ENERGIES IN TERMS OF PERTURBATION THEORY. Greiser, A. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 333-4(Oct. 1968).

Translated from Opt. Spektrosk., 25: 598-600(Oct. 1968).

A formalism based on the use of Green's functions for the Coulomb field is used to obtain simultaneously the Hartree–Fock wave functions and the energies of one-electron atoms from the formulas of perturbation theory. (A.G.W.)

22889 POSITRONIUM IN CRYSTAL LATTICE FIELD. Urbanovich, S. I. (Inst. of Solid State Physics, Minsk). Dokl. Akad. Nauk BSSR, 11: 587-9(July 1967). (In Russian).

Calculations of the energy of interactions between induced dipole moments of positronium atom (Ps) with electric field of given intensity showed that the Ps lifetime depends on the local electric field density and on the intercrystalline local field spectra. The binary character of the Ps structure results in double lifetimes. With the magnitude of the intracrystalline fields 4×10^7 v/cm $< E_{\text{intern.}} < 6.8 \times 10^8$ v/cm several lifetimes are possible. (R.V.J.)

22890 FACTORS AFFECTING THE ENERGY–RANGE RELATION OF FAST ELECTRONS IN ALUMINIUM. Nuesse, Michael (Gesellschaft fuer Strahlenforschung mbH, Frankfurt am Main). Phys. Med. Biol., 14: 315-21(Apr. 1969).

Factors which can influence measurements of the practical range of fast electrons are stated and discussed. These factors can be divided into geometrical parameters, like beam divergence, diameter of the beam and diameter of the detector, and into factors which influence particle energy. It is concluded that the energy-range relations of Katz and Penfold in aluminum and of Markus in water can be used in the energy range from 10 to 30 MeV with a maximum uncertainty of about 2%. (auth)(UK)

22891 ELECTRIC FIELD DEPENDENCE OF THE ANNIHILATION RATE OF POSITRONS IN HELIUM. Lee, G. F.; Orth, P. H. R.; Jones, G. (Univ. of British Columbia, Vancouver). Phys. Lett., 28A: 674-5(Feb. 24, 1969).

A dependence of the direct annihilation rate of positrons in helium gas on the electric field was observed. The results are compared to those predicted according to several current theories of the interaction between a positron and helium atom. (auth)

22892 EVIDENCE FOR THE EMISSION OF SLOW POSITRONS FROM POLYETHYLENE. Madey, John M. J. (Stanford Univ., Calif.). Phys. Rev. Lett., 22: 784-7(Apr. 14, 1969).

A carrier-free ^{58}Co source of positrons was mounted a few millimeters behind a polyethylene film. Positrons passing through the film were detected by a spectrometer. The energy spectrum of positrons transmitted by a 0.014-in. film is shown. (A.G.W.)

22893 THEORY AND MEASUREMENT OF THE X-RAY SATELLITE REFLECTIONS IN HOLMIUM DUE TO THE ASPHERICAL 4f CHARGE DENSITY. Keating, D. T. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 178: 732-42(Feb. 10, 1969).

The theory and experimental measurement of the satellite reflections appearing about the normal Laue–Bragg reflections in holmium are discussed. The reflections arise from the asphericity of the 4f charge density as distinct from the core charge density. In holmium metal, the $5d^1$ and $6s^2$ valence electrons are believed to enter the conduction bands, leaving a tripositive ion core approximated by the configuration $^5I_8$. The 4f shell lacking four electrons is screened from the crystalline environment by the filled $5s^2$ and $5p^6$ shells. Because of the unpaired electrons in the 4f shell, the ions have a magnetic moment that, between 20 and 132°K, tends to align them in a flat spiral with a propagation vector τ lying along the hexagonal axis of the crystal. This tendency of the ions to order into such a spiral, coupled with the aspherical charge density, induces periodicities in the scattering of the structure containing the first three even harmonics of τ. These periodicities produce x-ray satellite reflections about all allowed reflections except $(00\bar{0} \cdot L)$ at ± 2, ± 4, and $\pm 6\tau$. At a nonzero temperature the ions are disordered to the extent that they are distributed among states with magnetic quantum number M and inner quantum number J = 8. Using the molecular-field approximation suggested by Nagamiya to describe this disorder, it was found that past observation of neutron satellite intensities of Koehler et al. were explained. The theory was then used to calculate the average x-ray-scattering factor from the scattering factors for the various ionic states M whose computation rests upon parameters derived by Blume et al. from recently determined Hartree–Fock wave functions. The agreement with experimentally observed values of the scattering of the first satellite pair about the $(22\bar{4} \cdot 0)$ reflection discussed is excellent. (auth)

22894 APPROXIMATE ANALYTICAL SOLUTIONS OF THE THOMAS–FERMI–DIRAC AND THOMAS–FERMI–DIRAC–GOMBAS EQUATIONS. Csavinszky, P. (TRW Systems, Redondo Beach, Calif.). J. Chem. Phys., 50: 2476-85(Mar. 15, 1969).

Approximate analytical solutions of the Thomas–Fermi–Dirac (TFD) and Thomas–Fermi–Dirac–Gombás (TFDG) differential equations are obtained for neutron and positively charged atoms. The approximate solutions are of the form $\psi = \phi_0 + \eta$ and $\Psi = \phi_0 + \tilde{\eta}$, respectively, where ϕ_0 is a universal approximate analytical solution of the Thomas–Fermi (TF) differential equation for neutral atoms and η and $\tilde{\eta}$ are correction functions. The function ϕ_0 has been obtained previously, by making use of a variational principle (the equivalent of the TF equation), and the functions η and $\tilde{\eta}$ are determined by solving second-order inhomogeneous liner differential equations with the boundary and subsidiary (normalization) conditions that are required in the TFD and TFDG models, respectively. The correction functions η and $\tilde{\eta}$ depend on the atomic or ionic radius, which, in turn, depends on the atomic number Z and electron number N of the system considered. The approximate solutions ψ and Ψ are tested by calculating the first ionization energies of Ar, Kr, and Xe. The values obtained are about the same as those calculated from the exact numerical solution of the TFD and TFDG equations. In three Appendices approaches for improved approximate analytical solutions of the TFD and TFDG equations are outlined. Appendix A proposes an iterative procedure for obtaining the correction functions η and $\tilde{\eta}$ in successively more refined approximations, which is expected to be of importance for multiply charged ions or for neutral atoms of low atomic number. Appendix B establishes a variational principle (which to the author's knowledge has not been formulated before) for obtaining approximate analytical solutions of the TFD and TFDG equations, or for achieving further refinements in the approximate solutions ψ and Ψ that are derived in this paper. Appendix C describes Jensen's modification of the TFD and TFDG models, which, with the technique developed in this paper, enables one to obtain approximate analytical solutions for negative ions. (auth)

22895 ROTATIONAL PROPERTIES ASSOCIATED WITH THE HEITLER–LONDON MODEL OF H_2. Beckel, Charles L. (Georgetown Univ., Washington, D. C. Univ. of New Mexico, Albuquerque). J. Chem. Phys., 50: 2372-5(Mar. 15, 1969).

The first-order WBK approximation has been used to determine rotational constants B_v and D_v for the Heitler–London (HL) model of the H_2 ground electronic state. Near-equilibrium characteristics of B_v and D_v are discussed briefly in terms of the potential expansion about r_e. Overall, the HL and experimental B_v curves have nearly the same shape. The HL B_v curve has negative curvature at all v converging at a slightly slower rate than the experimental curve at high v. This slower convergence is associated with the $1/r^2$ factor used in defining B_v. The HL D_v curve, like the corresponding experimental curve, rises rapidly in the vicinity of dissociation. Both increases are attributed to a breakdown in the approximation that treats the centrifugal reaction term as a perturbation of the rotationless problem. The reliability of the first-order WBK approximation is checked and found to lead to only slight errors in the B_v and D_v values. (auth)

22896 CHARGE-OVERLAP EFFECTS. DISPERSION AND INDUCTION FORCES. Kreek, H.; Meath, William J. (Univ. of Western Ontario, London, Can.). J. Chem. Phys., 50: 2289-2302 (Mar. 15, 1969).

For nondegenerate atom–atom and atom–ion interactions the long-range interaction energy is expressed as a sum of "nonexpanded" angular components. If charge overlap is neglected each of the nonexpanded energies goes to a well-defined limit; namely to one of the usual R^{-1}-expanded induction or dispersion energies or else to zero (R is the internuclear separation). The R^{-1} expansions appear to be asymptotic expansions of the nonexpanded results and are valid only for large R. As specific examples the $H-H^+$ and $H-H$ interactions are considered as model systems for studying charge overlap effects in induction and dispersion forces. The calculations are carried out variationally using the complete discrete Laguerre functions of degree $(21 + 2)$

as a radial basis set. The asymptotic nature of the R^{-1} expansions for these interactions is discussed by comparing the various expanded and nonexpanded results. The importance of the nonexpanded interaction energies is also discussed briefly in general. (auth)

22897 SEMICLASSICAL APPROXIMATION FOR THE TOTAL CROSS SECTION OF ATOM–DIATOMIC-MOLECULE COLLISIONS; QUENCHING OF GLORY UNDULATIONS. Miller, William H. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 50: 3124-6(Apr. 1, 1969).

A semiclassical approximation for the total cross section of atom–diatomic-molecule scattering is proposed; a rigid-rotor model for the diatomic molecule is assumed. Numerical results showing quenching of glory undulations are plotted for several combinations of anisotropic parameters. Results are compared with those of other investigators. (A.G.W.)

22898 ABSORPTION SPECTRUM OF THE He_2 MOLECULE IN THE 510- TO 611-A RANGE. Tanaka, Y.; Yoshino, K. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Chem. Phys., 50: 3087-98(Apr. 1, 1969).

New vacuum-uv absorption phenomena in helium are reported. The most important of these consist of bands between 600 and 611 Å. Individual bands exhibit diffuse rotational structure and together form a v′ progression. They are attributed to the transition $A\,{}^1\Sigma_u^+ \leftarrow X\,{}^1\Sigma_g^+$ of He_2. Several rotational constants B_v for the upper state are noted. The dissociation energy and the term value of the upper state are estimated. A minimum height for the potential "hump" in the upper state is determined to be 0.059 eV. The close connection between the emission and absorption bands of He_2 around 600 Å is indicated and discussed. The location of the He-continuum (emission) peak is worked out in relation to the A-state term value and the ground-state potential function. A number of absorption bands were also observed in the range from 510 to 600 Å. They are attributed to other singlet systems relating to ns and nd orbitals ($n > 2$). (auth)

22899 MAXIMUM IONIZATION CROSS SECTION OF ATOMS. Tiwari, Prabhakar (Banaras Hindu Univ., India); Rai, D. K.; Rustgi, M. L. J. Chem. Phys., 50: 3040-45(Apr. 1, 1969).

Various theoretical approaches for estimation of maximum ionization cross sections are discussed and three new relations are developed and used to evaluate maximum cross sections. Mann's calculations are critically examined, and the present results are compared with available experimental results. (auth)

22900 DISSOCIATIVE ATTACHMENT OF ELECTRONS IN AMMONIA AND AMMONIA-d_3. Sharp, T. E.; Dowell, J. T. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). J. Chem. Phys., 50: 3024-35(Apr. 1, 1969).

Cross sections for total negative ions and amino negative ions have been measured as a function of energy for dissociative attachment of electrons in the gases NH_3 and ND_3. Two peaks are observed, at 5.65 and 10.5 eV. Both peaks contain $H^-(D^-)$ and $NH_2^-(ND_2^-)$. Small direct isotope effects were found, in negative ion production, except for H^-/D^- formation at 5.65 eV where the isotope effect was 1.0. The peak at 5.65 eV leads to products in their ground states. The corresponding potential-energy-vs-internuclear-distance ($H-NH_2$) curve for NH_3^- may contain a hump or may merely have a shallow slope in the Franck–Condon region. The peak at 10.5 eV arises from a repulsive state of NH_3^-, and the amino fragment is formed in an excited state. Empirical trends in the isoelectronic series methane, ammonia, and water are identified. (auth)

22901 EXCITATION OF ALKALI ATOMS BY ELECTRON IMPACT. Mathur, K. C.; Tripathi, A. N.; Joshi, S. K. (Univ. of Roorkee, India). J. Chem. Phys., 50: 2980-3(Apr. 1, 1969).

Electron-impact excitation cross sections of alkali-metal atoms are calculated in a classical impulse approximation, using a quantal momentum distribution function for the atomic electrons in the ground state. The results are compared with the experimental and other theoretical results. (auth)

22902 APPROXIMATE HIGHER IONIZATION POTENTIALS FOR THE HEAVIER ELEMENTS. Kastner, S. O. (Goddard Space Flight Center, Greenbelt, Md.). J. Chem. Phys., 50: 2896-2901(Apr. 1, 1969).

Approximate ionization potentials for the higher stages of ionization of elements $Z = 31$ to 92 are computed using the limiting screening constants of Froese. They are compared with available values for lower Z. (auth)

22903 IMPROVED STATISTICAL EXCHANGE APPROXIMATION FOR INHOMOGENEOUS MANY-ELECTRON SYSTEMS. Herman, Frank.; Van Dyke, John P.; Ortenburger, Irene B. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev. Lett., 22: 807-11(Apr. 21, 1969).

An improved exchange approximation was developed for use in self-consistent atomic-structure calculations and related problems. By adding an inhomogeneity correction to the Kohn–Sham–Gaspar exchange potential, one can obtain total energies for atoms that are consistently closer to the Hartree–Fock values than are those given by other recently proposed exchange potentials. (auth)

22904 OBSERVATION OF RESONANCE EFFECT IN MODULATED FLUORESCENT LIGHT FROM COHERENTLY EXCITED $4^2S_{1/2}$ AND $4^2P_{1/2}$ LEVELS IN $^4He^+$. Hadeishi, Tetsuo (Univ. of Arizona, Tucson). Phys. Rev. Lett., 22: 815-16 (Apr. 21, 1969).

A resonance phenomenon was observed in the fluorescent light from $^4He^+$ at a frequency corresponding to the interval between the nondegenerate Zeeman components β and f of the $4^2S_{1/2}$ and $4^2P_{1/2}$ states excited by an electron beam modulated at the corresponding frequency (uhf microwave). The observations can be interpreted as "quantum beats." An observation recently described in this way is better considered as a time-dependent level-crossing effect. (auth)

22905 INTENSE POLARIZED ELECTRON BEAMS FROM OPTICALLY PUMPED HELIUM DISCHARGES. McCusker, M. V.; Hatfield, L. L.; Walters, G. K. (Rice Univ., Houston, Tex.). Phys. Rev. Lett., 22: 817-20(Apr. 21, 1969).

Spin conservation in ionizing reactions involving optically oriented 2^3S_1 metastable helium atoms in a helium discharge has been exploited to produce a continuous beam of polarized electrons. A beam polarization of (10 ± 0.5)% is measured, with beam current 0.2 μA. Electrons extracted from the pulsed discharge afterglow have polarization (14 ± 0.7)%. The apparatus is simple and versatile, and should be readily adaptable to atomic and nuclear scattering experiments. (auth)

22906 SCATTERING OF HIGH-ENERGY ATOMIC BEAMS: THE DETERMINATION OF ATOM–MOLECULE POTENTIAL-ENERGY FUNCTIONS. Fink, Richard D.; King, John S. Jr.; Freeman, John H. (Amherst Coll., Mass.). J. Chem. Phys., 50: 2773-4(Mar. 15, 1969).

Average total cross sections for scattering of neutral beams of helium atoms over the energy range from 330 to 610 eV by CF_4, CHF_3, and CH_2F_2 are reported. The parameters K and s in the atom–molecule potential-energy function, $V(r) = K/r^s$, were also calculated. Calculated potential energies agree within approximately 20% with those previously obtained at M.I.T. (A.G.W.)

22907 APPROXIMATE HARTREE–FOCK ENERGIES OF THE 1^1S AND 2^3S STATES OF THE HELIUM ATOM USING THREE-PARAMETER ORBITALS GENERALIZED FROM SLATER AND GAUSSIAN FUNCTIONS. Carrier, Robert H.; Pilar, F. L. (Univ. of New Hampshire, Durham). J. Chem. Phys., 50: 2771-3(Mar. 15, 1969).

Some calculations on the He atom were carried out using trial wave functions constructed from antisymmetrized products of spin orbitals whose spatial portions are of the general form $\phi_i(\alpha_i, n_i, m) = Nr^{n_i} \exp(-\alpha_i r^m)$, where N is a normalization factor and α_i, n_i, and m are variational parameters. When $n_i = 0$ and $m = 1, 2$ the above orbital reduces to the familiar Slater and Gaussian 1s function, respectively. Results are tabulated for some single-determinantal energies of the He atom; in four calculations one of the parameters was fixed and in the fifth all three parameters were varied. The results are very good approximations of the Hartree–Fock energies. On the basis of these calculations and preliminary calculations on the hydrogen molecules and the hydride ion, it is expected that these functions should be rather good basic functions for use in other types of atomic and molecular calculations. (A.G.W.)

22908 DIRECT CALCULATION OF NATURAL ORBITALS BY MANY-BODY PERTURBATION THEORY: APPLICATION TO HELIUM. Reinhardt, William P.; Doll, Jimmie D. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 50: 2767-8(Mar. 15, 1969).

Natural orbitals are simple linear combinations of the basis orbitals and should be calculable as eigenfunctions of an operator of the same dimensionality as the one-electron basis set; this operator is the first-order reduced density matrix (1-matrix). It is shown that the 1-matrix may be calculated directly by many-body perturbation theory. The s-type natural orbitals for the He ^1S ground state in the radial limit calculated by this method are compared with natural orbitals calculated from a variational wave function by Lowdin and Shull. Calculated occupation numbers and diagonal overlaps are also tabulated. (A.G.W.)

22909 DOUBLE PERTURBATION THEORY FOR He-LIKE SYSTEMS. Tuan, Debbie Fu-tai (Kent State Univ., Ohio.

Yeshiva Univ., New York). J. Chem. Phys., 50: 2740-5(Mar. 15, 1969).

The He-like system is considered to be a spherical harmonic oscillator with the electrons attracted to the nucleus by a Hooke's-law force, under two perturbations: (1) electronic repulsion, $H^{(1,0)}$, and (2) the difference between the harmonic oscillator potential and the actual nuclear Coulomb attraction, $H^{(0,1)}$. For the ground state, the first-order wave functions with respect to both perturbations are found in closed form. Exact expressions for both of the single perturbation energies through third order and the mixed perturbation energy $\epsilon^{(1,1)}$ are derived. Calculations have been carried out on H^-, He, Li^+, and Be^{2+} for different choices of f, the Gaussian parameter of the zeroth-order harmonic oscillator wave function $\psi^{(0,0)}$. The choice $f = (4/3\pi^{1/2})\,[Z - (1/2\sqrt{2})]$ corresponding to the variational one-term Gaussian orbital of a He-like system gives the best total calculated energy, −2.88210 a.u. for helium compared to the experimental and "exact" value of −2.90372 a.u. From the study of the convergence of the perturbation energies, it is concluded that so far as correlation is concerned the first-order perturbation with respect to $H^{(1,0)}$ is accurate enough. Higher-order perturbations with respect to the one-electron operator $H^{(0,1)}$ will be needed for highly accurate results. However, even at the first-order level the Gaussian character of $\psi^{(0,0)}$ is improved tremendously by the perturbation $H^{(0,1)}$. This is shown by the values of $\epsilon^{(0,2)} + \epsilon^{(0,3)}$, of the order of −0.4 to −0.6 a.u. (auth)

22910 DESTRUCTION OF METASTABLE HELIUM ATOMS IN BINARY COLLISIONS. LoDato, Vincent A. (IBM East Fishkill Facility, Hopewell Junction, N. Y.); Katsuura, Kanji. J. Chem. Phys., 50: 2588-94(Mar. 15, 1969).

A theoretical calculation of the total cross section of the destruction of metastable helium atoms $He(2^3S)$ by ionization has been performed by means of the impact parameter method with a number of suitable approximations. The cross section obtained is of the order of $10^2\ a_0^2$, which is in good agreement with the experimental order of magnitude of Phelps and Molnar and shows the error in the theoretical calculation of von Roos. (auth)

22911 DISSOCIATION OF CARBON DIOXIDE IN THE POSITIVE COLUMN OF A GLOW DISCHARGE. Corvin, K. Kutszegi; Corrigan, S. J. B. (Univ. of Oklahoma, Norman). J. Chem. Phys., 50: 2570-4(Mar. 15, 1969).

The dissociation of CO_2 by electron impact was investigated in the positive column of a dc glow discharge for gas pressures between 0.3 and 4 mm Hg and a current of 0.6 mA in a tube of radius 1.25 cm. The reaction rate was determined by separating and measuring the noncondensable products formed. The effects of the cathode and anode regions of the discharge were eliminated by varying the interelectrode distance to obtain the axial electric field in the positive column and also the molecular dissociation rate per unit length of column. The number of dissociating collisions α_d/p by an electron drifting unit length along the field direction of the positive column was measured for values of E/p between 11 and 32 $V\ cm^{-1} \cdot (mm\ Hg)^{-1}$ showing corresponding values of α_d/p of 0.15 and 0.67 at these limits. The measured rate coefficients show that dissociation proceeds via uncharged species. A reaction mechanism $CO_2 + e \rightarrow CO + O$ is consistent with the observed phenomena. It is suggested that the dissociative excitation is to a $^3\Pi$ state of CO_2 about 6.1 eV above the ground state. Assuming an onset potential of 6.1 eV, a cross section that rises to a maximum of $3.5 \times 10^{-17}\ cm^2$ at 6.9 eV and then rapidly decreases with increasing electron energies, is compatible with the observed dissociation-rate coefficients. (auth)

22912 DIPOLE PROPERTIES OF MOLECULAR HYDROGEN. Victor, G. A. (GCA Corp., Bedford, Mass.); Dalgarno, A. J. Chem. Phys., 50: 2535-9(Mar. 15, 1969).

Experimental data on electron scattering, optical refractivity, and molecular anisotropy are used to construct a model dipole spectrum for molecular hydrogen, which is consistent with oscillator-strength sum rules. The model spectrum is used to calculate the parallel and perpendicular dynamic dipole polarizabilities, the refractive index, the Verdet constant, the Rayleigh scattering cross section, the Rayleigh depolarization factor, and the molecular anisotropy as a function of frequency of the incident radiation. The tensor components of the van der Waals coefficient for a pair of interacting hydrogen molecules are also calculated. (auth)

22913 EXPONENTIAL SOLUTION OF THE SCHROEDINGER EQUATION: POTENTIAL SCATTERING. Chang, Daniel; Light, John C. (Univ. of Chicago). J. Chem. Phys., 50: 2517-25(Mar. 15, 1969).

The exponential matrix method of Magnus is applied to the solution of the time-independent Schroedinger equation for potential scattering. The formal properties of this method as a numerical technique are analyzed and the close connections to the WKBJ approximation are also shown. The use of the Magnus series is shown to yield the correct behavior near the origin without the Langer modification of the WKBJ equation. Applications to the scattering from above a potential barrier and to the phase shifts for a Lennard–Jones (12–6) potential are given. (auth)

22914 EXCITATION OF HELIUM BY HYDROGEN IONS IN THE 1 TO 150-keV REGION. van den Bos, Jan. Amsterdam, Univ. of Amsterdam, 1967. 130p. Thesis.

Cross sections for excitation of He by H^+, H_2^+, and H_3^+ were measured in the energy range from 1 to 150 keV. Polarization of the emitted light was also measured. A theoretical treatment of the excitation of He by proton impact in the first-order impact-parameter formulation is presented. By means of Fourier transforms a simple formula for the excitation cross section as a function of energy is found. Comparison of the excitation cross sections for the three projectiles as a function of impact velocity shows that the gross behavior is very similar, although the direct excitation by H_2^+ and H_3^+ may have contributions from electron-exchange processes. At low energies it is concluded that the probability for excitation increases in the order H^+, H_2^+, H_3^+. The high-energy behavior of the cross sections varies, in the singlet case, approximately as 1/E for the S and D excitation and as (log E)/E for P excitation. The high-energy proton results are in reasonable agreement with the Born approximation. (A.G.W.)

22915 TOWNSEND IONIZATION COEFFICIENT FOR He WITH INDIRECT IONIZATION BEING TAKEN INTO ACCOUNT. Lozanskii, E. D. Dokl. Akad. Nauk SSSR, 183: 315-18(Nov. 11, 1968). (In Russian).

He reacts with resonance photons to give excited He atoms that give secondary electrons as a result of the reaction: $He(3P) + He \rightarrow He_2^+ + e^-$. This reaction has a cross section σ of about $10^{-15}\ cm^2$. Estimates show that at a value of E/p = 8 volts/cm · mm Hg std the fraction of electrons from the above reaction exceeds by an order of magnitude the fraction of electrons obtained by direct electron collision. The excited 3^1P level also has a characteristic quenching time; that is, it decays to other levels without the emission of an electron. A formula is derived for the drift velocity of the electrons, which agrees well with experiment for values of E/p of 3 volts/cm · mm Hg std and higher. Values of α in cm^{-1}/p in mm Hg std were calculated for E/p values for 3 to 100 volts/cm · mm Hg std, and were found to compare favorably with the experimental data. Here α is the Townsend ionization coefficient. (TTT)

22916 QUASISTATIONARY STATES IN A CONICAL POTENTIAL WELL. Nikitin, E. E. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR, 183: 319-22(Nov. 11, 1968). (In Russian).

For a multiatomic system there is, in principle, a possibility of connecting the adiabatic electron terms of the same symmetry. The simplest situation is realized in a system of three identical atoms in a ^2S state with the configuration of an equilateral triangle. In two coordinates describing the deviation of the system from a symmetric configuration, the adiabatic electron terms corresponding to the lower and first excited doublet state have the form of two apparent peaks of circular cones. In a conical potential well (higher term) there exist quasi-stationary states that can be decomposed because of the nonadiabatic connection of the electronic and nuclear motions. Expressions are given for the radial equations and the nonadiabatic relation, the energy levels, the level width, and the classification of states in the conical well. These quasi-stationary states can occur during optical excitation of symmetrical triatomic molecules, during charge transfer of symmetrical triatomic ions, and also may be developed during resonance scattering of an atom on a diatomic molecule consisting of atoms of the same type. (TTT)

22917 ON THE EIGENFUNCTION EXPANSION CONNECTED WITH THE EXTERIOR PROBLEM FOR THE SCHROEDINGER EQUATION. Ikebe, Teruo (Kyoto Univ.). Jap. J. Math., 36: 33-55(1967).

Differential operators of the form $-\Delta + q(x)$ were studied in an exterior domain in 3-space with the Dirichlet boundary condition. The Green functions were constructed for the Dirichlet problem in the case when q(x) vanishes identically. Then these Green functions were employed to obtain the eigenfunctions of the form of plane wave plus outgoing wave satisfying the radiation condition at infinity, in terms of which an arbitrary square integrable function over the exterior domain can be in an integral similar to the ordinary Fourier integral in 3-space. The tools and methods for the case of not identically vanishing q(x) are dealt with briefly. (M.H.R.)

22918 CORRELATION STRUCTURE IN ATOMS. Kelly, Hugh P. (Univ. of Virginia, Charlottesville). Advan. Theor. Phys., 2: 75-169(1968). (ORO-2915-59).

The use of the many-body perturbation theory of Brueckner and Goldstone (BG) in calculating atomic wave functions and energies for atoms with more than two electrons is discussed. The BG linked-cluster perturbation expansion is reviewed. The various terms of the expansion and methods of summing classes of terms are considered. The problem of choosing a basis set of single-particle states for the expansion is considered. The consequences of using a Hartree–Fock basis set are discussed and alternative basis sets are proposed. The correlation energy among electrons in atoms is discussed. Experimental results are compared with theoretical calculations. Multiple perturbations in atomic physics are studied. Particular application is made to polarizabilities, shielding factors, and polarization potentials. Time-dependent perturbations are also considered. (A.G.W.)

22919 H(2S) ATOMS PRODUCED BY DISSOCIATIVE EXCITATION OF MOLECULES. Clampitt, R. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Lett., 28A: 581-2(Jan. 27, 1969).

Metastable $H(2^2S_{1/2})$ atoms have been produced by electron-beam excitation of gaseous H_2, H_2O, NH_3, C_2H_2, C_2H_4, and C_3H_8 and have been resolved by time-of-flight methods. Estimates of threshold energies and kinetic energies are reported. (auth)

22920 ATOMIC PHOTOIONIZATION CROSS SECTION CALCULATION. Amus'ya, M. Ya.; Cherepkov, N. A.; Chernysheva, L. V.; Sheftel, S. I. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 28A: 726-7(Mar. 10, 1969).

Essential peculiarities of the Hartree–Fock photoionization cross section are discussed: (1) the choice of the operator of interaction with the electromagnetic field, (2) sum rules, and (3) the influence of various modifications of the self-consistent field. (auth)

22921 ON THE ATOMIC SHELL STRUCTURE IN IONISATION CROSS SECTION. Tripathi, D. N.; Rai, D. K.; Tiwari, P. (Banaras Hindu Univ., India). Phys. Lett., 28A: 757-8(Mar. 10, 1969).

Total absolute cross sections for alkali metals have been calculated for incident-electron energies up to 1 keV using Gryzinski's classical formula with the average kinetic energy of the atomic electron as suggested by Vriens. The results have been compared with the earlier work of Garcia and experimental observations. (auth)

22922 FREE VOLUME MODEL FOR POSITRONIUM DECAY IN MOLECULAR MATERIALS. Thosar, B. V.; Kulkarni, V. G.; Lagu, R. G.; Chandra, Girish (Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 28A: 760-1(Mar. 10, 1969).

A free-volume model is developed to describe the experimentally observed correlation between the value (τ_2) and the intensity (I_2) of the slow component in the lifetime spectra of positrons in amorphous solids and simple liquids, semicrystalline polymers, and molecular crystals. Phase changes are interpreted in terms of this model. (A.G.W.)

22923 EMISSION IN THE EXTREME ULTRAVIOLET FROM AUTOIONIZING LEVELS OF H_2 AND D_2. Sroka, W. (Univ., Hamburg). Phys. Lett., 28A: 784-5(Mar. 10, 1969).

In H_2 and D_2 radiation having wavelengths shorter than the ionization wavelengths can be excited by electron bombardment. Two components are found in H_2; there are six components in D_2. (auth)

22924 ALTERNATE-GRADIENT FOCUSING OF NEUTRAL PARTICLES. Kakati, D.; Laine, D. C. (Univ. of Keele, Eng.). Phys. Lett., 28A: 786-7(Mar. 10, 1969).

Alternate-gradient focusing of neutral particles in a molecular beam is shown experimentally to produce conditions for (a) enhanced absorption, (b) stimulated emission, and (c) a voltage-dependent transition of (b) to (a) upon variation of geometrical parameters. (auth)

22925 TOTAL IONIZATION AND IONIZATION FLUCTUATIONS IN HELIUM. Alkhazov, G. D.; Vorob'ev, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 29A: 25-6 (Mar. 24, 1969).

The mean energy for ion production W, the Fano factor F, and some other quantities inherent to electron ionization cascades in helium are computed from semiempirical cross sections for excitation and ionization. W = 46 eV and F = 0.21 at an electron energy of 2.5 keV. (auth)

22926 IONIZATION OF ATOMS BY POSITIVE ION BOMBARDMENT NEAR THRESHOLD ENERGY. Sheldon, J. W. (Florida State Univ., Tallahassee). Phys. Lett., 29A: 2-3 (Mar. 24, 1969).

An expression for the cross section for ionization of atoms by ion bombardment near threshold energy is obtained in terms of the photoionization cross section of the target atom and the elastic-scattering cross section of the ion–atom collision partners. (auth)

22927 COLLECTIVE EXCITATIONS OF THE MANY-ELECTRON ATOM. Dmitriev, Yu. Yu.; Labzowskii, L. N. (Leningrad State Univ.). Phys. Lett., 29A: 44-5(Mar. 24, 1969).

A variational principle for the direct calculation of the excitation energy of a many-electron atom is constructed. The variational calculation of the collective excitation for a neon atom gives $\Delta E_{coll} = 68.2$ eV. (auth)

22928 MEAN LIVES OF EXCITED TERMS IN Be I, Be II, B I, B II, C II, AND C III. Bergstroem, I.; Bromander, J.; Buchta, R.; Lundin, L.; Martinson, I. (Research Inst. for Physics, Stockholm). Phys. Lett., 28A: 721-2(Feb. 24, 1969).

25 mean lives of excited terms in Be I, Be II, B I, B II, C II, and C III were measured with the beam foil technique, using ion energies in the range 40 to 80 keV. (auth)

22929 THE TOTAL IONIZATION IN METHANE OF IONS WITH $1 \leq Z \leq 22$ AT ENERGIES FROM 10 TO 120 keV. Macdonald, J. R.; Sidenius, G. (Univ. of Copenhagen). Phys. Lett., 28A: 543-4(Jan. 27, 1969).

Measurements in methane of the total number of ion pairs produced by ions with $1 \leq Z \leq 22$ at energies from 10 to 120 keV have shown a periodic element dependence for a given energy of the incoming ions. (auth)

22930 DEPENDENCE OF THE IONIZATION CROSS SECTION OF EXCITED HYDROGEN ATOMS ON THE PRINCIPAL QUANTUM NUMBER. Krinberg, I. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Propagation, Novosibirsk, USSR). Sov. Astron. AJ (Engl. Transl.), 12: 840-3(Mar.-Apr. 1969).

Translated from Astron. Zh., 45: 1061-5(Sept.-Oct. 1968).

The cross section $\sigma_n(U)$ for ionization of the n-th level of a hydrogen atom by electron impact is proportional to n^4 as $U \to 1$ (where $U = E/E_n$ is the ratio of the energy of the incident electron to the energy of ionization of the level), and to n^3 as $U \to \infty$. A semiempirical formula is obtained for $\sigma_n(U)$, which (1) yields the above dependence of σ_n on the principal quantum number n; (2) agrees, for $U > 30$ and all n, with the values for σ_n computed in the Born approximation; and (3) agrees for $n = 1$ with available experimental data for the range $U = 1$ to 40. (auth)

22931 ESTIMATES OF THE EFFICIENCIES OF PRODUCTION AND DETECTION OF ELECTRON-EXCITED AUGER EMISSION. Bishop, H. E.; Riviere, J. C. (Atomic Energy Research Establishment, Harwell, Eng.). J. Appl. Phys., 40: 1740-4 (Mar. 15, 1969).

The efficiency of production of electrons emitted by the Auger process from the surface of a solid irradiated with a beam of electrons in the energy region below 2 keV is estimated. It is shown that the probability of photon production is negligible and that to a first approximation the optimum primary energy required for the ionization of an inner atomic level is between 3 and 3.5 times the critical ionization potential of that level. Calculation of the Auger current is made for a chosen system, that of oxygen adsorbed on a copper surface, and is found to be about 2×10^{-11} A in the group of oxygen peaks around 500 eV, for a complete monolayer, detected on a spherical screen of the size typically found in LEED display systems. Consideration of the two methods, the retarding field and the electrostatic deflection, that have been used for detection of Auger currents, leads to the conclusions that, in the retarding-field analyzer, the current in the second derivative increases as the square of the amplitude of modulation up to an amplitude about one-half that of the rms width of the Auger peak, and thereafter tends to a constant value, whereas in the electrostatic-deflection analyzer, the current in the second derivative increases linearly with amplitude of modulation up to an amplitude about one-third that of the rms width, passes through a maximum, and, beyond an amplitude about six times the rms width, decreases again as the inverse square root of the amplitude. (auth)

22932 SURFACE IONIZATION: AN EXPERIMENTAL STUDY OF STRONTIUM AND LANTHANUM ON TUNGSTEN. Reynolds, Frederick L. (Univ. of California, Berkeley). Surface Sci., 14: 327-39(Apr. 1969).

The ionization of Sr and La was studied on the (110), (100) crystal surfaces of W and on polycrystalline W surfaces. It was shown that differences amounting to as much as 0.25 eV occur in the value of the surface work function when comparing Sr or La on the same surface. The work function of the W(110) plane was found to be 5.52 ± 0.05 eV. The value found for the W(100) plane is 4.56 ± 0.04 eV. Trace amounts of oxygen attack the W(100) crystal surface at elevated temperatures, exposing other planes and permanently reducing the work function of this surface. (auth)

22933 LARGE-ANGLE ION SCATTERING FROM A SINGLE CRYSTAL. Dahl, P.; Sandager, N. (Univ. of Aarhus, Denmark). Surface Sci., 14: 305-19(Apr. 1969).

The scattering of argon ions from atoms in the first and the second atomic plane of a (100) gold surface is investigated for outgoing directions forming small angles (≤20°) to the surface. The scattering involves one violent collision and weak collisions with the neighboring atoms. The double collision phenomena expected from a theoretical analysis are observed. The data interpretation yields information on the structure of the surface cleaned by sputtering, on thermal vibrations of atoms in the first atomic plane, and on charge-state distributions for specified scattering centers and ion trajectories. (auth)

22934 ISOTOPE SHIFT IN THE $2^1S_0-2^1P_1$ LINE OF HELIUM. Burger, James M.; Lurio, Allen (IBM Watson Lab., New York). Phys. Rev. Lett., 22: 755-7(Apr. 14, 1969).

The isotope shift in the $2^1S_0-2^1P_1$ (2.06-μ) line of helium has been measured for the first time and found to be 4200 ± 140 MHz. This measurement is a sensitive test of the mass-polarization contribution to the isotope shift and is found to be in excellent agreement with the calculations of Pekeris. (auth)

22935 REFLECTION OF A THERMAL-ENERGY ATOMIC BEAM OF SILVER BY POLYCRYSTALLINE NICKEL AND MOLYBDENUM. Daury, G. (Institut d'Optique Theorique et Applique, Paris); Constans, A.; Lostis, P.; Degras, D. A. Surface Sci., 14: 103-20(Mar. 1969). (In French).

The reflection patterns of a thermal atomic beam of silver impinging a hot nickel or molybdenum surface shows a semispecular reflection of the incident atoms. In the case of molybdenum, the crystallographic evolution of the surface resulting from the working temperature induces alterations of the reflection patterns. A parametric description of the experimental data is proposed and the corresponding parameters can be calculated even in the general case where many elementary reflection lobes are found. (auth)

22936 IONIZATION OF GASES BY FAST N^+ AND N^{2+} IONS. Pivovar, L. I.; Levchenko, Yu. Z.; Grigor'ev, A. N.; Khazan, S. M. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 56: 736-42(Mar. 1969). (In Russian).

The ionization of He, Ne, Ar, Kr, H_2, and N_2 by singly and doubly charged nitrogen ions is investigated at energies in the 0.2- to 1.8- and 0.5- to 1.8-MeV ranges respectively. The data obtained in the present investigation on the total cross sections for slow-ion and electron production are compared with the experimental data on the cross sections for electron loss or capture by N^+ and N^{2+} ions obtained by the mass-spectrometric technique. The magnitudes of the pure ionization cross sections are estimated and compared with the simplified Bethe–Born approximation. It is found that even for energies exceeding 1.4 MeV an effective charge can be introduced, which is approximately equal to 1.64 q for N^+ ions (q is the proton charge). (auth)

22937 ON THE THOMAS–FERMI EQUATION. Hille, Einar (Univ. of New Mexico, Albuquerque). Proc. Nat. Acad. Sci. U. S., 62: 7-10(Jan. 1969).

Preliminary results are reported from a study of some mathematical aspects of the Thomas–Fermi equation, including (1) convergence of relevant series, (2) existence of unbounded solutions, (3) existence of solutions having an arbitrary branch point, (4) determination of a class of solutions bounded for large values of the variable, and (5) determination of a class of solutions unbounded for small values. (auth)

22938 ELECTRONIC TRANSITION MOMENTS FOR THE LYMAN BAND OF H_2. Browne, J. C. (Univ. of Texas, Austin). Astrophys. J., 156: 397-8(Apr. 1969).

There are reported computed electronic transition moments as a function of internuclear separation for the Lyman bands of H_2. These are in agreement with experiment where the experimental values are available. (auth)

22939 RELATIVE TRANSITION PROBABILITIES FOR SILICON. Miller, Myron H.; Bengtson, Roger D. (Univ. of Maryland, College Park). Astrophys. J., 156: 393-5(Apr. 1969).

Measured relative gf values are reported for thirteen prominent visible lines of Si I. These data do not conform well to the predictions of LS coupling. Using the new results drastically reduces scatter in determinations of the solar abundance of silicon. (auth)

22940 OSCILLATOR STRENGTHS AND WAVELENGTHS OF SOME X-RAY AND EXTREME-ULTRAVIOLET SPECTRUM LINES OF HIGHLY IONIZED IRON. Chapman, Robert D. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 156: 87-91 (Apr. 1969).

Oscillator strengths are presented for x-ray and extreme ultraviolet transitions between configurations with principal quantum numbers $n \leq 4$, in the spectra Fe XXV, Fe XXIV, Fe XXIII, and Fe XXII. (auth)

Cosmic Radiation

Refer also to abstracts 22823, 22859, 23325, 23326, 23331, 23345–23352, 23370, and 23746.

22941 (AD–673475) LOW-ENERGY SOLAR COSMIC RAY LATITUDE INTENSITY STRUCTURE AND PITCH ANGLE DISTRIBUTIONS AT LOW ALTITUDE. Blake, J. B.; Paulikas, G. A.; Freden, S. C. (Aerospace Corp., El Segundo, Calif.). Mar. 1968. 32p. (TR–0158(3260-20)-8; SAMSO-TR–68-282). CFSTI.

Solar protons (1.1 to 1.6 MeV) and alpha particles (4.1 to 15 MeV) were observed over the polar caps associated with the proton event of August 28, 1966. Persistent latitudinal structure in the proton flux was observed. Ordering of the structure by magnetic latitude over both polar caps during a given orbit shows that it is a spatial effect associated with nonuniform access of solar protons to high latitudes. Examples of the latitudinal structure are shown. Pitch-angle distributions were observed, which clearly delineated a region of quasi-trapping; the changes in the pitch-angle distributions during a representative pass as the spacecraft, 1966-70A, traversed the region of quasi-trapping are shown. No evidence for the durable containment of the quasi-trapped solar alpha particles was observed. (USGRDR) (auth)

22942 (N–68-36900) COSMIC GAMMA-RAYS FROM METAGALACTIC PROTON-ANTIPROTON ANNIHILATION. Stecker, F. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 1968. 17p. (NASA-TM-X-63368; X-641-68-390). CFSTI.

It is shown that annihilation gamma radiation has a characteristic spectrum which distinguishes it from other types of cosmic gamma radiation. Such spectra are presented, based on the results of accelerator experiments on antiproton annihilation and also including cosmological distortions of local annihilation-gamma-ray spectra. Using the baryon inhomogeneity cosmology, it may be possible to account for both the observed cosmic isotropic x-rays and gamma rays as due to red-shifted annihilation-gamma-radiation where the mean value of the product of interacting matter and antimatter densities is of the order of 10^{-18} cm^{-6}. (auth) (STAR)

22943 (N–68-37233) SURVIVAL OF HEAVY NUCLEI IN COLGATE'S SUPERNOVA COSMIC-RAY ACCELERATION MODEL. Kinsey, James H. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Sept. 1968. 29p. (NASA-TM-X–63363; X–611-68-352). CFSTI.

The supernova acceleration model for cosmic rays of Colgate is examined to see if heavy nuclei can indeed survive catastrophic acceleration. If it is assumed that all species of nuclei are collectively accelerated by a mechanism such as a plasma-wave instability in a shock wave, then the only agent remaining to dissociate heavy nuclei in Colgate's model is the blue-shifted photon flux in the radially outward-moving shock wave. This would cause a sharp cutoff of the heavy component of cosmic rays from photodisintegration for cosmic-ray energies greater than 10^3 GeV/nucleon. (auth) (STAR)

22944 (N–68-37235) GAMMA-RAY PRODUCTION IN PARAFFIN BY COSMIC RAYS. Chupp, E. L.; Forrest, D. J.; Lavakare, P. J. (New Hampshire Univ., Durham. Dept. of Physics). Sept. 1968. 15p. (NASA-CR-97253; UNH–68-9). CFSTI.

Gamma-ray production was measured at balloon altitudes in large paraffin blocks surrounding a central gamma-ray detector. This shielding was considered for use with detectors in balloon solar gamma-ray astronomy for the 0.2- to 4.0-MeV region. Four boxes of household paraffin were arranged so they could be removed from proximity to the central detectory by a radio command. The gamma-ray pulse-height spectrum was recorded with and without paraffin shielding. Study of respective counting rates showed the paraffin acting as an absorber of the ambient gamma-ray spectrum by decreasing the counting rate and local gamma-ray production from capture and scattering of ambient neutrons in the paraffin, which enhances the counting rate at an observable peak at 2.22 MeV. (STAR)

22945 (N-68-37754) THE COSMIC GAMMA-RAY SPECTRUM FROM SECONDARY PARTICLE PRODUCTION IN THE METAGALAXY. Stecker, F. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 1968. 26p. (NASA-TM-X-63369; X-641-68-391). CFSTI.

The purpose of this paper is to discuss the form and intensity of the spectrum of cosmic gamma rays resulting from the production and decay of neutral pi mesons produced in metagalactic cosmic-ray p–p collisions. It is assumed that intergalactic space contains ionized hydrogen gas at a density of 10^{-5} cm^{-3} as is consistent with recent x-ray observations at 0.25 keV. Two models are presented to represent the possible flux of metagalactic cosmic rays. In calculating metagalactic gamma-ray spectra, the effect of gamma-ray absorption at large red shifts is taken into account. A discussion of the results is given. The results indicate that future gamma-ray experiments in the region 1 to 100 MeV, may yield valuable information relating to cosmology, cosmogony, and the metagalactic cosmic-ray flux. In particular, the metagalactic gamma-ray spectra predicted tend to peak near $70\ (1 + z_{max})^{-1}$ MeV where z_{max}, the maximum red shift at which cosmic rays are produced, may correspond to the age of the Universe at the epoch of galaxy formation. (auth) (STAR)

22946 ANGULAR VARIATIONS OF THE SPECTRAL INDEX OF NONTHERMAL COSMIC RADIO EMISSION. Tokarev, Yu. V. (Gorky Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 161-7(1969). (In Russian).

Regular and irregular variations of the spectral index of cosmic radio emission are considered, when the radiation pattern of the receiving antenna is moved over the sky. (auth)

22947 COSMIC RAY MUON INTENSITIES AT 80° TO THE ZENITH. Palmer, N. S.; Nash, W. F. (Univ. of Nottingham, Eng.). Nucl. Phys., B9: 315-23(1969).

Details are presented of the construction of a cosmic ray spectrograph utilizing a solid iron magnet and flash tube detectors. The instrument was orientated to accept muons incident near the geomagnetic north–south direction with zenith angles close to 80°. Some 11,500 usable single events were obtained, and a description is given of the analysis of the data. Detailed consideration of the various instrumental corrections has enabled the muon spectrum in the energy range 4 to 500 GeV to be determined. The data were interpreted in terms of both kaon and pion parentage of muons and are found to be consistent with an upper limit of 0.4 for the K/π ratio. There is no evidence for the direct production of muons as reported by Bergeson et al. (auth)

22948 SOLAR RESEARCH FROM ROCKETS AND SATELLITES. Widing, Kenneth G. (Naval Research Lab., Washington, D. C.). Astronaut. Aeronaut., 7: 36-43(Mar. 1969).

Instrumentation and results of extreme uv (XUV) and x-ray (to 2 Å) spectrum studies employing rocket-borne equipment are reviewed. Within the uv part of this solar echellogram, more than 7000 atomic absorption lines have been measured at a resolution of about 0.03 Å with a wavelength precision of 0.01 Å, or better. The first goal of solar XUV research has already been reached, i.e., mapping out in a series of snapshots the previously inaccessible XUV portion of the spectrum to the shortest wavelength possible with the best spatial and spectral resolution attainable with rockets. XUV spectrographs have used the concave diffraction grating as the main dispersing imaging element. High efficiency over the spectral range 3000 to 1100 Å is obtained when the spectrum is formed with mirrors and gratings that are used near normal incidence and are coated with a special reflecting surface of aluminum overcoated with MgF_2. The great intensity and importance of the hydrogen Lyman-α line has invited a series of special studies and experiments. For example, a spectroheliograph experiment recorded the distribution of L-α emission over the solar disk, as is shown. An example of the solar-emission line spectrum in the 200-Å region, photographed by a grazing-incidence spectrograph, is illustrated. Solar flare and corona spectral studies are also described. (BBB)

22949 ORIGIN OF MUON-POOR EXTENSIVE AIR SHOWERS. Maze, R. (Lab. of Cosmic Physics, Verrieres le Buisson, France); Wdowczyk, J.; Wolfendale, A. W.; Zawadzki, A. Phys. Rev. Lett., 22: 899-901(Apr. 28, 1969).

Consideration is given to the relative intensities of muon-poor extensive air showers observed at mountain altitudes and at sea level. It is shown that the available results to date do not support the earlier hypothesis that primary gamma rays are responsible, and instead, a process involving charged primary cosmic rays is indicated. (auth)

22950 THE PROPAGATION AND ANISOTROPY OF COSMIC RAYS. I. THEORY FOR STEADY STREAMING. Wentzel, Donat G. (Univ. of Maryland, College Park). Astrophys. J., 156: 303-14(Apr. 1969).

Cosmic rays steadily streaming along a uniform magnetic field and down a cosmic-ray density gradient are considered. The anisotropy generates hydromagnetic waves which, in turn, scatter the cosmic rays. Both the shape of the cosmic-ray distribution function and the wave spectrum for a steady state with a low cosmic-ray streaming velocity are derived. The results are summarized and limits of validity are discussed in terms of a numerical example. (auth)

22951 PREDICTIONS OF EXTRAGALACTIC GAMMA RAY FLUXES BETWEEN 1 AND 100 MeV. Stecker, F. W. (Goddard Space Flight Centre, Greenbelt, Md.); Silk, J. Nature (London), 221: 1229-31(Mar. 29, 1969).

It is stated that knowledge of isotropic cosmic γ radiation in the 1- to 100-MeV region would help to determine the relative importance of the various processes which may produce the observed isotropic x radiation below 1 MeV and the γ radiation above 100 MeV. The first process examined as a possible explanation for the radiation below 1 MeV was Compton interaction between metagalactic cosmic-ray electrons and photons of the universal microwave radiation field. Additional processes which may be important in producing extragalactic γ radiation are cosmic-ray electron bremsstrahlung interaction with intergalactic matter, collisions of cosmic-ray nuclei with intergalactic matter which result in the production of pi mesons, and the mutual annihilation of matter and antimatter on possible boundary regions of baryon inhomogeneity in the universe. Some implications of previous studies are discussed as regards distinguishing the γ-ray spectra produced by the various processes, and an endeavour is made to place upper limits on the metagalactic cosmic-ray electron and nuclear fluxes. It is concluded that observational studies of isotropic γ radiation between 1 and 100 MeV are critical for determining the dominant processes producing γ rays in the metagalaxy, and their cosmological implications. (UK)

22952 ZENITH ANGLE DEPENDENCE OF METEOROLOGICAL EFFECTS ON MUONS OBSERVED AT 60 m.w.e. UNDERGROUND. Peacock, D. S. (Imperial Coll. of Science and Tech., London). J. Atmos. Terrest. Phys., 31: 355-65(Mar. 1969).

Inclined cubical and vertical semicubical telescopes at 60 mwe were used to monitor the secondary muon flux due to primary cosmic-ray particles of energies of the order of 100 GeV during the recent minimum of solar activity. The counting rates of all sets of directional telescopes were significantly correlated with sea-level pressure, upper air temperature (in the range 200 to 70 mb) and height of the atmosphere. The resulting regression coefficients were found to be independent of telescope direction. The north pointing inclined telescopes responded only to daily variations of atmospheric origin. This enabled the local contribution to the daily variations observed by east pointing and vertical telescopes to be set at 0.015% or less with a 95% confidence limit. (auth) (UK)

22953 SHORT TIME VARIATIONS OF THE COSMIC-RAY DIURNAL PHASE AND AMPLITUDE DETERMINED BY MEANS OF SUPERIMPOSED RECORDS. Sandstroem, A. E.; Shutrasakul, L.; Thayarnyong, S. (Univ. of Uppsala). Ark. Geofys., 5: 449-61(1969).

The possibility is discussed of studying the diurnal variation by superimposing the records from a number of cosmic-ray stations inside a limited rigidity region. This was applied to 10 events. The results are given in the form of diagrams. The applicability and limitations of the method are discussed. (Sweden)

22954 GEOMAGNETIC DISTURBANCES AND THE COSMIC-RAY DIURNAL VARIATION. Shutrasakul, L.; Thayarnyong, S. (Univ. of Uppsala). Ark. Geofys., 5: 475-80(1969).

It is well known that the phase and amplitude of the cosmic-ray diurnal variation vary during geomagnetic disturbances. It was found that this occurs even in the case of very small Forbush decreases. The variation starts about one or two days before the magnetic storm. This can be seen more easily after separation of the daily variation from the worldwide intensity variations. During quiet days the time of maximum is in the afternoon which supports the assumption that the normal solar time diurnal variation of cosmic rays is due to particles corotating with the Sun. The variations during a Forbush decrease are very complicated. (Sweden)

22955 SHORT-LIVED FORBUSH DECREASES. Pak, Byung-so (Univ. of Uppsala). Ark. Geofys., 5: 421-36(1969).

Short-lived Forbush decreases which took place on May 9, 1958, August 29, 1960, and November 17–18, 1966, were analyzed all over the world by means of neutron and meson monitors. Through regression analysis on data from several stations it was demonstrated that phase differences among stations had clearly existed not only during the onset time but also the whole phase. The cause of this anisotropy is discussed in view of the change of asymptotic directions by the deformed geomagnetic field and of the spatial anisotropy in space as well. (Sweden)

22956 DAY-TO-DAY VARIABILITY OF THE DAILY VARIATION OF COSMIC RAYS DURING THE QUIET PERIOD OF THE SOLAR ACTIVITY. Pak, Byung-so (Univ. of Uppsala). Ark. Geofys., 5: 515-28(1969).

A method is described for calculation of the day-to-day variability of the daily variation of the cosmic-ray intensity using high-latitude neutron monitor data. Variances of time of maxima, minima and their differences were calculated for each solar rotation period, by superimposing first and second harmonics as well as by smoothing the values. Several factors which may affect the analysis are also discussed. A considerable correlation was found between the variances of maxima and minima and the solar activity expressed in Zurich relative sunspot number. This was not revealed by long-time-averaged analyses. A negative correlation between the variances and averaged amplitudes over the period also appeared from the study. It was concluded that the daily variation may be characterized as follows: (a) The Axford–Paker theory on the daily variation is consistent with the observations on some days, (b) an azimuthal streaming could not manifest itself as a daily variation in the counting rate of the detectors, or the present analytical method is not sufficient to decide these physical quantities, (c) a separate mechanism responsible for the time of minimum would be operating on some days and independent of the time maximum, so the daily variation of the cosmic-ray intensity can not be approximated by a diurnal variation. (Sweden)

22957 THE COSMIC-RAY DIURNAL VARIATION DURING AN EVENT ON DECEMBER 23–24, 1957. Sandstroem, Arne Eid (Univ. of Uppsala). Ark. Geofys., 5: 491-500(1969).

A method was developed by which it is possible to determine the direction of the cosmic-ray anisotropy during successive hourly or bihourly intervals. It was applied to an event starting on Dec. 23, 1957, which could be expected to display a very much enhanced diurnal variation. The results show that from 0000 UT on the 23rd to 0200 UT on the 24th the direction of the anisotropy varied between 30 and 123° from the Earth–Sun line in the morning direction. The amplitude of the diurnal variation increased from "normal" magnitude to a peak of about 3% between 1700 UT and 1900 UT on the 23rd whereafter it returned to its former magnitude. Before as well as after the event the anisotropy had a late afternoon direction. (Sweden)

Direct Energy Conversion

Refer also to abstract 22651.

22958 (AD-674883) RESEARCH AND DEVELOPMENT PROGRAM OF THERMIONIC CONVERSION OF HEAT TO ELECTRICITY. VOLUME II. Final Technical Summary Report. (General Electric Co., Pleasanton, Calif. Nuclear Thermionic Power Operation). July 1968. Contract NObs-90496. 115p. (GEST-2062(Vol.2)). CFSTI.

Efforts in the following areas are reported: (1) The development of cesium-resistant metallizing coatings for pure alumina ceramics; (2) the development of molybdenum–alumina cermet structures for use as emitter–collector seal insulators; (3) the evaluation and/or development of methods of bonding the metallic surface of insulators to structural metal numbers; (4) long-time testing of materials and seals at high temperatures in both vacuum and cesium vapor environments. (USGRDR)

22959 (BLG-427) COMPILATION OF REFERENCES ON THE DIRECT CONVERSION OF HEAT INTO ELECTRICAL ENERGY. Contzen, J.-P.; Bemelmans, P. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). July 1968. 208p. (In French). Dep.

A collection of a little over one thousand references is presented, dealing with the production of electrical energy by direct conversion from a heat source. The period of time covered extends up to the years 1963–1964. The references are sorted out under main headings and subheadings, according to the conversion mode and to the particular aspect investigated. (auth)

22960 (DLR-FB-67-38) INTERACTION OF DIAMAGNETIC PARTICLES WITH A MAGNETIC CHANGING FIELD. Peschka, Walter; Tries, Bruno (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt e. V., [Porz] (West Germany). Institut fuer Energiewandlung und Elektrische Antriebe). June 1967. 75p. (In German). Dep.

Some calculations have been made on the interaction of diamagnetic particles with a magnetic oscillating field for energy conversion devices. It is shown that an acceleration or deceleration (a pressure increase or decrease) of a gas flow can be caused by suspension of metallic particles in the flow through the magnetic oscillating field. Further investigations in this area with regard to possible application in analogy to inductive MHD generators are of interest. (auth)

22961 (NP-17774) THERMIONIC RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report No. 3. Jacobson, D. L.; Hamerdinger, R. W. (Electro-Optical Systems, Inc., Pasadena, Calif.). Feb. 3, 1969. Contract 952217. 60p. (EOS-4006-Q-3).

For Jet Propulsion Lab., Pasadena, Calif.

An investigation was made of single-crystal rhenium and tungsten alloy materials of the following composition: 85% W/15% Re, 95% W/5% Re, 95% W/5% Os, 97.5% W/2.5% Os, 99% W/1% Ir, 98% W/2% Ir, 95% W/5% Ta, 90% W/10% Ta, and 74% W/26% Ta. The purpose of the investigation is to yield a high bare work function surface. Specific investigations include vacuum emission vehicle determination of the effective work functions and examination of electrode surfaces using a thermionic emission microscope. Metallographic examinations are also included. Next, an investigation was made of CVD W/22 to 26 Re electrodes. Bare work function measurements are made with the vacuum emission vehicle, and the electrode surface is examined with the thermionic emission microscope. The electrode material is then incorporated into a variable parameter vehicle, a planar converter, and a cylindrical converter. The design, fabrication, and testing of CVD rhenium-electrode cylindrical thermionic converters for the principal purpose of providing a performance comparison between planar and cylindrical geometries are discussed. (auth)

22962 STUDY OF AN ELECTRIC MODEL OF LINEAR AND MHD MACHINES WITH LIQUID JETS. Poloujadoff, Michel; Sabonnadiere, Jean-Claude (Institut Polytechnique, Grenoble, France). Compt. Rend., Ser. A, B, 267: 1412-15(Dec. 23, 1968). (In French).

When the level distribution of the secondary current densities is analyzed, an equivalent scheme is obtained having an element with distributed constants. This simple equivalent scheme, during practical development, can be replaced by a group of elements with localized constants analogous to that of the quadrupole representation of the energy transport lines. (J.S.R.)

22963 THERMIONIC CONVERTER DEVICE. Grover, George M.; Busse, Claus A.; Caron, Rene Jean (to United States Atomic Energy Commission). U. S. Patent 3,441,752. Apr. 29, 1969.

A new thermionic converter for directly converting heat into electrical energy is provided. It comprises an emitter, a collector, a first heat pipe for transferring heat from a heat source to the emitter surface, a second heat pipe for transferring heat away from the collector surface to a heat sink, tubular means for introducing an easily ionizable gas into the space between the emitter and collector, and means enclosing the above elements. (AEC)

22964 EFFECTS OF ELECTRODE TEMPERATURE ON MHD GENERATOR PERFORMANCE. Kessler, Robert. Stanford, Calif., Stanford Univ., 1968. 115p.

Thesis.

Experiments were performed in a combustion-driven MHD generator to determine the effects of electrode temperature and boundary-layer temperature on its performance. The generator was a single electrode pair guarded to avoid end effects by two electrode pairs both upstream and downstream. The five electrode pairs were preceded either by a cold (750°K) water-cooled metal plate or by a hot (2400°K) wall made of magnesium oxide. The electrodes were held at three temperature levels—775, 1475, and 1685°K—by controlling individual cooling circuits. Two sets of electrode boundary-layer temperature profiles were investigated: one resulting from the cold metal upstream wall and the other resulting from the hot ceramic upstream wall. Probes were installed in the insulator sidewall between the center pair of electrodes to measure the voltage profile in the gas. Visual and photographic observations of the electrodes were made. End effects were found to be small, so that results may be interpreted in terms of a five-electrode-pair generator. The generator with hot electrodes downstream of hot walls produced about seven times the power of the generator with cold electrodes downstream of cold walls. Electrode voltage drops were found to increase with load current, and to decrease with increasing electrode and upstream-wall temperatures. Voltage drops at the cathode were larger than at the anode. The difference decreased with increasing upstream-wall and electrode temperatures. To interpret the experimental data, an electrical model of the boundary layer was postulated. The total boundary layer resistance is composed of three parts: the surface resistance (losses due to emission from cold surfaces), the gas-surface interface, or sheath, and the ohmic resistance due to the cold gasdynamic boundary layer. The gasdynamic resistance was calculated by integrating an equilibrium conductivity profile to a point one local Debye length from the electrode surface. It was assumed that this marks the boundary between the gas-dynamic effects and the surface-sheath effects. The calculated values of the gasdynamic resistance agreed well with experimentally determined values of the anode resistance, obtained from probe data. The difference between resistances of cathode and anode boundary layers was attributed to surface and/or sheath effects at the cathode. (Disser. Abstr.)

22965 MHD RESEARCH: PRESENT AND FUTURE. Thring, M. W. (Sheffield Univ., Eng.); Ibberson, V. J. Engineer, 227: 474-7(Mar. 28, 1969).

Research on magnetohydrodynamic power generation is reviewed. Progress on modulated systems, including the use of a shock-wave generator, and on nonequilibrium ionization methods is outlined. (UK)

Fluid Physics

Refer also to abstract 23134.

22966 DISSIPATIVE EFFECTS IN COMPRESSIBLE MAGNETOHYDRODYNAMIC FLOW. Gratzer, Louis Bernard. Seattle, Univ. of Washington, 1968. 145p.
Thesis.

A general approach to the study of compressible dissipative magnetohydrodynamic (HMD) flow is developed based on the linearized MHD equations for a flow with small perturbations in a uniform stream with constant applied magnetic field. No restriction is placed on the range of values of the important physical parameters such as viscosity, heat conductivity, electrical conductivity, compressibility, etc. The general solution of the MHD equations is presented and shown to be applicable to any physical problem characterized by equations of this type. The concept of the fundamental modes corresponding to sources of the MHD equations is developed as a basis for treating boundary value problems within the framework of the linearized theory. The study of the fundamental modes is found to provide an ideal basis for understanding the influence of the various flow parameters; i.e., Reynolds number, Mach number, Prandtl number, Magnetic Prandtl number, Alfvén number and magnetic field direction. The results of a detailed study of the MHD fields corresponding to the swept fluid source line and the swept z-force line are presented to illustrate the important phenomena associated with the flow about an infinite swept cylinder. All the properties of the MHD flow which are predicted on the basis of simpler theories are in evidence and, in addition, the various dissipative phenomena such as wakes, jets and the attenuation of wave-type disturbances are treated quantitatively. (Disser. Abstr.)

22967 STABILITY OF A PLANE FLUID INTERFACE IN THE PRESENCE OF A TRANSVERSE ELECTROSTATIC FIELD. Raco, Roland J. (Newark Coll. of Engineering, N. J.); Peskin, Richard L. Phys. Fluids, 12: 568-75(Mar. 1969).

An equation of motion for the amplitude of the perturbation of the interface of two incompressible fluids is obtained under the specification of small viscosities and small electrical conductivities. This equation describes the motion of a damped harmonic oscillator with the effects of the electric field given as: (1) a forcing function proportional to the displacement, and (2) a forcing function proportional to the time integral of the displacement. A stability analysis of this equation shows how the electrical conductivity, surface charge, frequency of the applied field, viscosity, surface tension, electric permittivity, fluid depth, and density affect the stability of the fluid interface. The destabilizing effect of the surface charge and the stabilizing effect of the viscosity are illustrated for dc and ac applied fields. It is shown that the minimum dc destabilizing voltage can be lower than the value given by Taylor and McEwan, and that instability can result with an ac field that is about 0.2 the strength of the destabilizing dc field. (auth)

22968 FLOW OF A CONDUCTING LIQUID IN AN ANNULAR GAP. Ebtekar, Taghi. Philadelphia, Univ. of Pennsylvania, 1968. 71p. Thesis.

The problem of a liquid conductor (such as mercury) confined between two concentric cylindrical electrodes is considered. The liquid metal is electromagnetically accelerated by the Lorentz force in the circumferential direction created when a current is passed between the two electrodes (held at different potentials) and an axial magnetic field is maintained. The governing equations and boundary conditions are written allowing for the effects of viscosity, finite conductivity of the electrodes, gravitational and Lorentz body forces, and secondary flows. The potential and current-density distributions for the static problem have been calculated. Solutions have also been obtained for a problem related to the slow flow induced by the static field configuration. Experiments have been conducted both with and without an applied magnetic field. Circumferential magnetic field and electrostatic potential has been measured without an applied magnetic field. Velocities have been deduced from pressure measurements made with an applied magnetic field. For example, with a current of 100 Å through the device and an axial magnetic field of about 1500 gauss, velocities of the order of 35 cm/sec have been measured. (Diss. Abstr.)

22969 HYDROMAGNETIC FLOW WITH VARIABLE SUCTION IN LAMINAR PERIODIC BOUNDARY LAYERS. Pop, I. Bul. Inst. Politeh. Iasi, 13: 173-8(1967).

Investigations were conducted on hydromagnetic flow with variable (periodic) suction of an incompressible electrically conductive viscous fluid over an infinite porous plate in the presence of a steady magnetic field lying perpendicular to the plate plane. The effect of variable suction on the hydromagnetic flow and on the surface friction in the boundary layer is closely examined. It is inferred that the velocity of the motion and the amplitude of the surface friction amplitude are higher at higher suction rates (increase of parameter A), accompanied by a lower surface friction oscillation. (auth) (Rom. Sci. Abstr.)

22970 HYDROMAGNETIC STABILITY ANALYSIS OF JET-DRIVEN VORTEX FLOW. Chang, T. S. (North Carolina State Univ., Raleigh. Oak Ridge National Lab., Tenn.); Sartory, W. K. Plasma Phys., 10: 1029-38(Dec. 1968).

The stationary velocity profile near the outer wall of a jet-driven vortex tube is calculated according to the classical theory of laminar boundary-layer flow, neglecting the effects of wall curvature. The jet-velocity recovery ratios (tangential velocity extrapolated to wall/mean injection velocity) derived from the theoretical stationary velocity profiles agree well with the available measurements for magnetically stabilized vortex tube flow. An MHD Görtler-type stability analysis of the calculated stationary profiles under the influence of an externally applied axial magnetic field is considered. The fluid medium is assumed to be incompressible, viscous, and electrically conducting. The theoretical stability results are compared with the available experimental values and agreement is found to be rather poor. Possible reasons for the disagreement are discussed. (auth) (UK)

22971 HYDROMAGNETIC STABILIZATION EXPERIMENTS WITH JET-DRIVEN VORTEX FLOW. Keyes, J. J. Jr. (Oak Ridge National Lab., Tenn.). Plasma Phys., 10: 1039-49(Dec. 1968).

Experiments are described which demonstrate the stabilizing influence of an axial magnetic field on confined vortex flow of an aqueous electrolytic conductor generated by two-dimensional, tangential wall jets. For example, using a 10-cm-dia × 40-cm-long vortex tube having two feed jets and a single exit orifice at the center of one end, the tangential Reynolds modulus at transition to instability was increased from 500 with no magnetic field to 7600 under the influence of a 75-kG field (corresponding to a Hartmann modulus based on tube radius of 172). The experimental magnetic stabilization results for 1, 2 and 4 slit injection are correlated empirically. (auth) (UK)

22972 EXACT SOLUTION FOR ROTATING BODIES IN A VISCOUS CONDUCTING FLUID. Ranger, K. B. (Univ. of Toronto). Phys. Fluids, 12: 776-7(Apr. 1969).

An exact solution is found for the motion of a conducting solid of revolution rotating in an infinite conducting viscous fluid at rest at infinity. The magnetic field is the sum of a uniform field directed parallel to the axis and an induced toroidal field. Explicit expressions for the fluid velocity, magnetic field, and couple on the solid are given for the case of a sphere. (auth)

22973 THEORETICAL STUDY OF THE FREE SURFACE OF A MAGNETOHYDRODYNAMIC FLOW. Chambarel, Andre (Univ., Avignon, France). Compt. Rend., Ser. A, B, 268: 184-6(Jan. 20, 1969). (In French).

A theoretical study is presented of the free surface of a flow, in a horizontal rectangular channel, of an electroconducting liquid in the presence of a uniform magnetic induction field, vertical or horizontal. (tr-auth)

22974 EXACT SOLUTIONS OF THE HYDROMAGNETIC DYNAMO PROBLEM. Lortz, D. (Institut fuer Plasmaphysik, Munich). Plasma Phys., 967-72(Nov. 1968).

Exact solutions of the steady-state hydromagnetic equations with a solenoidal velocity field are derived for appropriate boundary conditions in a helical geometry. (auth) (UK)

22975 ELECTROHYDRODYNAMIC CHARGE RELAXATION AND INTERFACIAL PERPENDICULAR-FIELD INSTABILITY. Melcher, James R.; Smith, Charles V. Jr. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 12: 778-90(Apr. 1969).

The small-amplitude motions of a plane interface between two fluids stressed by an initially perpendicular electric field are investigated. The fluids are modeled as Ohmic conductors and the convection of the surface charge caused by the dynamic interplay of interfacial electric shear stresses and the viscous stresses is highlighted. The influence of viscosity on instability growth rates in the zero-shear stress limits of perfectly insulating interfaces is described and compared to cases involving electrical shear stresses. Detailed attention is given to the instability of an interface between fluids having electrical relaxation times long compared to times of interest. It is shown that, for many common liquids, even a slight amount of surface charge makes the interface unstable at a considerably lower voltage than would be expected from theories based on the dielectrophoretic limit of no interfacial free charge. Experiments, performed using high-frequency ac stresses, gradually increased dc fields, and abruptly applied dc fields, support the theoretical model. In the general case, the electric Hartmann number is identified as an index to the dominance of the electric shear stresses over the viscous shear stresses in determining the interfacial convection of free charge. (auth)

22976 BERNOULLI EQUATION IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Merches, I.; Teodorescu, V. (Alexandra I. Cuza Univ., Iasi). Plasma Phys., 10: 1025-6 (Nov. 1968).

By using the mass energy–momentum tensor given by Taub and the general form of the energy–momentum tensor of the electromagnetic field, a solution of the equation of motion for a plasma situated in an external electromagnetic field is obtained. This solution is just the generalization of Bernoulli's equation in relativistic magnetohydrodynamics. (auth) (UK)

Geophysics (Upper Atmosphere)

Refer also to abstracts 22707, 22826–22831, and 22867.

22977 (AD–672811) JSSG-SPACED RECEIVER MEASUREMENTS. Final Scientific Report. Liszka, Ludwik (Kungliga Vetenskapsakademien, Kiruna (Sweden). Geofysiska Observatoriet). Apr. 24, 1968. 77p. (AFCRL–68–0365). CFSTI.

The height of ionospheric irregularities was measured by several laboratories belonging to the Joint Satellite Studies Group, using spaced-receiver techniques. The method of analysis and results obtained are presented. (USGRDR) (auth)

22978 (AD–675461) MEASUREMENTS OF ELECTRON CONTENT AND LATITUDINAL F-LAYER CRITICAL FREQUENCY NEAR THE MAGNETIC EQUATOR. Special Technical Report No. 34. Nimit, Vichai T. (Stanford Research Inst., Menlo Park, Calif.). Dec. 1967. Contract DA-36-039-AMC-00040(E). 90p. CFSTI.

Faraday rotation data from Satellite S-66 were accumulated at the Electronics Laboratory, Bangkok, Thailand, from November 1964 through June 1967, a period of intermediate sunspot number (sunspot minimum condition at 1964/1965 and sunspot maximum condition at 1968/1969). These data provide a means of improving ionospheric frequency predictions for regions in Thailand remote from Bangkok (i.e., where no ionosonde data are available). In this report, two methods of analysis—involving rotation rate and total number of rotations—are applied to the Bangkok observations. The rotation-rate method is used to determine the electron content when the angle between the ray path and geomagnetic field is 90° (transverse position). The total-rotations method is used to determine latitudinal variations of electron content of the equatorial ionosphere for the selected passes from a joint analysis of observations at three stations in Thailand—Songkhla, Bangkok, and Chiengmai. (auth) (USGRDR)

22979 (N–68–37604) MEASUREMENT OF ELECTRIC FIELDS IN THE IONOSPHERE. VOLUME 1. SUMMARY TECHNICAL REPORT. Final Report, August 1966–September 1967. Levy, Gerald; Jacobs, Herbert; Bendor, Edgar (Fairchild Hiller Corp., Farmingdale, N. Y. Republic Aviation Div.). Sept. 1967. Contract NAS8-20663. 74p. (NASA-CR-98042; PCD-TR-67-9; FHR-3287-1). CFSTI.

A sensitive electric field meter which has a five order of magnitude dynamic range has been developed for use within the ionosphere and has been laboratory tested. The meter utilizes the technique of the deflection of an electron beam under the influence of the electric field to be measured. The deflection of the beam is monitored on a segmented target. Displacements as small as 10^{-5} mm are detected. The deflection signal is amplified and fed back to the deflection plates to continually null the virtual center of the beam. Two components of the electric field orthogonal to the beam direction are simultaneously measured. The output of the loop is synchronously detected and filtered. Thus a dc voltage level which is proportional to the electric field being measured is available for readout. Ambient electric fields within the ionosphere were measured to range from 10 mV/meter and less, up tp 100 mV/meter and more. The design analysis included plasma sheath and wake effects of the meter components and nearby bodies, the modification of the ambient electric field, and plasma properties due to the electron beam, and the attitude resolution requirements to determine the apparent electric field due to the $(\bar{v} \times \bar{B})$ of the spacecraft and magnetosphere which is inseparable from all electric field measurements. (auth) (STAR)

22980 (N–68–37713) MEASUREMENT OF ELECTRIC FIELDS IN THE IONOSPHERE. VOLUME 2. Final Report, August 1966–September 1967. Levy, Gerald; Jacobs, Herbert; Bendor, Edgar (Fairchild Hiller Corp., Farmingdale, N. Y. Republic Aviation Div.). Sept. 1967. Contract NAS8-20663. 124p. (NASA-CR-98043; PCD-TR-67-9-A; FHR-3287-2). CFSTI.

An experimental laboratory model of an electric field meter was developed using electron-beam-deflection techniques. Designed for operation in the vicinity of a spacecraft in the ionosphere, the meter uses a weak beam of less than $1\ \mu A$ so that the environment and field are not disturbed. The meter has a dynamic range from 10 to 1000 V/meter with an accuracy of ±1 mV/meter at 10 mV/meter and ±1% above 100 mV/meter. Instrument design and performance are detailed, including laboratory testing; and mission categories, concepts, and constraints are considered. Attention is also given to the interaction of bodies with the ionosphere, including the undisturbed ionosphere and the surface potential, the near field of region B, and the plasma sheath. (STAR)

22981 (N–68–37753) CONVECTION ELECTRIC FIELDS AND THE DIFFUSION OF TRAPPED MAGNETOSPHERE RADIATION. Birmingham, Thomas J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Sept. 1968. 42p. (NASA-TM-X-63374; X-641-68-356). CFSTI.

The possible importance of time-dependent convection electric fields as an agent for diffusing trapped magnetospheric radiation inward toward the Earth is considered. Using a formalism based on first principles, and adopting a simple model for the magnetosphere and its electric field, a one-dimensional diffusion equation is derived to describe statistically the loss free motion of mirroring particles with arbitrary but conserved values of the first two adiabatic invariants M and J. Solution of this equation bears out the fact that reasonable electric field strengths, correlated in time for no longer than the azimuthal drift period of an average particle, move particles toward the Earth at a rate at least an order of magnitude faster than electric fields whose source is a fluctuating current on the magnetopause. (auth) (STAR)

22982 (UCRL–5354) SOURCES OF EARLY TELLER LIGHT. Parker, Lee W. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 18, 1958. 12p. Dep. CFSTI.

A semiquantitative description is given of what may be expected to give rise to the early Teller light. Several possible sources are considered, namely, band emission from excited molecules and continua due to recombination, bremsstrahlung, and Cherenkov radiation. It is shown that the band emission is strongly predominant. (auth)

22983 EXPERIMENTAL INVESTIGATION OF SLOW AMPLITUDE AND PHASE VARIATIONS OF 10 cm RADIO WAVES ON TRACES NEAR THE EARTH. Kiselev, O. N.; Korotkova, V. M.; Leskov, N. M.; Polishchuk, Yu. M.; Sharygin, G. S. (Tomsk Inst. of Radioelectronics and Electronic Tech., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 9-14(1969). (In Russian).

Experimental data are presented on slow-amplitude and phase fluctuations of 10-cm radio waves in propagating on traces near the Earth extended up to 200 km under conditions of the rugged terrain in West Siberia. (auth)

22984 PROPAGATION THEORY OF WHISTLING ATMOSPHERICS. Spiridonov, Yu. G. (Moscow Physico-Technical Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 44-53(1969). (In Russian).

The trajectories of whistling atmospherics in the magnetosphere are calculated under the assumption that the electron density varies exponentially with height. The dependences of the delay time and the latitude of arrival on the output angle are obtained. It is shown that at a smooth variation of the electron density with height, there takes place the discrete trajectories for which as a result of focusing a considerable increase of the field intensity at the arrival point is observed. The dispersion characteristics of whistling atmospherics propagating along these trajectories are presented. (auth)

22985 TO THE THEORY OF FORMATION OF PROLATE IRREGULARITIES IN IONOSPHERIC F2 REGION. Troitskii, B. V. (Tomsk Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 15-19(1969). (In Russian).

The stability of ionospheric plasma with application to the F2 region is studied, taking into account the density gradient and regular drift motion of charged particles. The plasma is shown to be unstable relative to the groove-type perturbation. This instability may be the reason for the formation of prolate small-scale irregularities in the ionospheric F2 region. (auth)

22986 LOWER IONOSPHERE ELECTRON DENSITIES MEASURED DURING THE SOLAR ECLIPSE OF NOVEMBER 12, 1966. Mechtly, E. A. (Univ. of Illinois, Urbana); Seino, K.; Smith, L. G. Radio Sci., 4: 371-5(Apr. 1969).

The University of Illinois and the GCA Corporation, supported by NASA, launched four Nike-Apache rockets from Cassino, Brazil, during the solar eclipse of November 12, 1966. The measurement of D-region ionization loss rates was the principal aeronomic objective of the four rockets. Each rocket carried a 3385-kHz radio propagation experiment and a Langmuir probe. The probe data were calibrated by the radio data to give electron number densities. At the mesopause (82 km) the electron densities were 800, 400, and 100 cm^{-3} at full Sun (2 hours after totality), at 2.5% visibility of the solar disk, at second contact and at third contact, respectively. The full-Sun measurement of electron density at 65 km was 100 cm^{-3}. By the time of second contact, the electron density diminished to less than 10 cm^{-3} at 70 km and below. At the time of the third contact, the electron density was less than 10 cm^{-3} at 75 km and below. No significant differences were visible between the electron densities observed at second and third contact and at 2.5% visibility for altitudes between 95 and 100 km. A well-defined sporadic-E layer was observed at 104 km. (auth)

22987 BALLOON OBSERVATIONS OF PROTON FLUXES DURING THE PCA PERIOD, MAY 23-30, 1967. Kremser, G. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.); Saeger, K. H.; Riedler, W. Ark. Geofyz., 5: 481-90(1969).

During the PCA period from May 23-30, 1967, six balloons were launched from Kiruna to measure the altitude profile in the atmosphere of the incident proton flux. Protons were encountered during two of these flights, K V/67 and K VI/67, on May 28 and 29. The measurements yielded the following information: Steepness, γ, of the proton energy spectrum: $\gamma_V = 4.0$, $\gamma_{VI} = 4.6$. Decrease of the proton flux between both flights for energies $E > 56$ MeV from $J_V = 1.0$ protons/cm^2/sec ster to $J_{VI} = 0.2$ protons/cm^2/sec ster. The balloon observations are in accordance with preliminary data from the VELA 4 satellite. (Sweden)

22988 STUDIES ON AURORAL HYDROGEN EMISSION USING AN IMAGE INTENSIFIER. Francis, R. J.; Jacka, F. (Univ. of Adelaide). J. Atmos. Terrest. Phys., 31: 321-37 (Mar. 1969).

An image intensifier and camera were used to obtain photographs of the whole sky at two wavelengths. Interference filters were used to select the wavelengths, one centered on 4859 Å to pass Doppler-shifted H_β and one on 4879 Å to assess the background emission. The equipment and data reduction methods are described in detail. Isophotes of H_β emission over a 6° latitude range are presented from the analysis of four nights of observations from Mawson, Antarctica, in 1964. The concept of an emission zone fixed in space relative to the Sun and "invariant" poles is found to be useful but oversimplified. Usually the maximum H_β intensities were about 30 Rayleigh. On one occasion a higher intensity (approximately 70 R) was observed, poleward of the usual emission zone, with sudden onset and associated with a slowly varying ionospheric absorption event and increased magnetic activity. This occurrence is interpreted as an aspect of the auroral substorm phenomenon. (auth) (UK)

22989 F-REGION ELECTRON CONCENTRATIONS AT SOLAR ACTIVITY MINIMUM. Watkins, C. D.; Taylor, G. N. (Royal Radar Establishment, Malvern, Eng.). J. Atmos. Terrest. Phys., 31: 339-45(Mar. 1969).

Incoherent scatter measurements of F-region electron concentrations between altitudes of 130 and 450 km, made from a mid-latitude station at all times of day in April and October 1964, are presented and discussed. (auth) (UK)

22990 CALCULATION OF ELECTRON DENSITY PROFILES FROM OBLIQUE IONOGRAMS. Gething, P. J. D. (Government Communications Headquarters, Cheltenham, Eng.). J. Atmos. Terrest. Phys., 31: 347-54(Mar. 1969).

A simple iterative procedure is described for the calculation of an electron density profile from an oblique ionogram. A concentric, spherically stratified ionosphere is assumed. At each stage in the iteration a theoretical oblique ionogram is calculated from the approximation to the profile, using a ray-tracing program. The theoretical and observed ionograms are compared and the profile is adjusted until satisfactory agreement is obtained. (auth) (UK)

22991 PROPAGATION OF AN ELECTRON PLASMA RESONANCE WAVE IN THE F REGION. Bouchet, P. (CEPCA, Orsay, France). J. Atmos. Terrest. Phys., 31: 367-82(Mar. 1969). (In French).

The magneto-ionic theory predicts two possibilities of inducing from the Earth an electron plasma resonance wave in the F region. Within the framework of the adiabatic approximation with scalar pressure it is shown by a propagation example that, after thermal electron agitation, the only possibility of attaining plasma resonance that exists is that corresponding to the emission of a wave whose vector is oriented towards magnetic north in the northern hemisphere. (auth) (UK)

22992 THE "LUNI-SOLAR" IONOSPHERIC TIDES. Brown, R. A. (London Univ.). J. Atmos. Terrest. Phys., 31: 383-95 (Mar. 1969).

A new interpretation of luni-solar tides in the ionosphere is presented, based on the production of "sum and difference frequencies" by the nonlinear response of the atmosphere to applied forces. This is applied in detail to the luni-solar tides in f_0F2 and h_mF2 at Ibadan using data for 12.3 yr from 1954 to 1966, and shown to apply equally to recently published results for other low-latitude stations. (auth) (UK)

22993 DYNAMICS OF THE F REGION OBSERVED WITH THOMSON SCATTER. I. ATMOSPHERIC CIRCULATION AND NEUTRAL WINDS. Vasseur, G. (CNET, Moulineaux, France). J. Atmos. Terrest. Phys., 31: 397-420(Mar. 1969).

Since June 1966 results from the French Thomson-scatter bistatic sounder (Saint Santin-Nançay) have yielded a considerable amount of data for the study of ionization transports in the F region. This paper shows the importance and scale of transports in the ionosphere, and describes the new method of measurement used at Nançay. Experimental results of about 20 diurnal variations, as described by hourly values of velocities, are presented. These velocities are interpreted as the sum of two effects: horizontal circulation of the neutral air, and ambipolar diffusion of ionization under gravity and under its own partial pressure. The two effects can be separated, giving an evaluation of neutral atmosphere velocities. (auth) (UK)

22994 OBSERVATIONS OF TRAVELING IONOSPHERIC DISTURBANCES USING STATIONARY SATELLITES. Elkins, T. J.; Slack, F. F. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Atmos. Terrest. Phys., 31: 421-39(Mar. 1969).

Observations, at a sub-auroral zone site, of transmissions from geo-stationary satellites, have revealed an unusual regular type of fading, apparently due to diffraction from moving ionospheric formations. The velocity of movement of these electron density irregularities was measured by means of a spaced receiver network which, in turn, allowed their height to be computed, in several instances, as well as certain other parameters of interest. The fading is deduced to result from electron density discontinuities, with linear gradients ~700 $cm^{-3}m^{-1}$, and located usually near the F-region maximum, travelling in a generally equatorwards direction at ~50 to 120 m/sec. Apparent periodicity in many fading events, and an association with ionosonde-measured disturbance suggest that the diffraction takes place at facets of travelling wavelike formations in the ionosphere. Additional observational evidence is presented to support a hypothesis of ducted acoustic-gravity waves, probably excited by impulsive auroral-zone events, and having horizontal wavelengths of ~50 to 100 km, with latitudinal extent, on occasion, exceeding 1500 km. (auth) (UK)

22995 NONLINEAR LOSS AND THE NIGHTTIME IONOSPHERIC F REGION. Cummack, C. H. (Geophysical Observatory, Christchurch, N. Z.). J. Atmos. Terrest. Phys., 31: 441-8(Mar. 1969).

The effects of the nonlinear processes of charge exchange and dissociative recombination on the decay of the night-time F region are examined. A comparison with linear theory shows little disparity near the layer maximum. Lower in the atmosphere the ionization densities are considerably underestimated by the linear theory. (auth) (UK)

22996 DATA NECESSARY FOR THE DETECTION AND DESCRIPTION OF TIDES AND GRAVITY WAVES IN THE UPPER ATMOSPHERE. Lindzen, Richard A. (Univ. of Chicago). J. Atmos. Terrest. Phys., 31: 449-56(Mar. 1969).

The purpose of this paper is to clarify, from the point of view of the theoretician and synoptician, the problem of measuring gravity waves and tides in the upper atmosphere. (auth) (UK)

22997 USE OF A HEIGHT MODEL TO STUDY NIGHTTIME RECOMBINATION. Bullen, J. M. (Geophysical Observatory, Christchurch, N. Z.). J. Atmos. Terrest. Phys., 31: 457-62 (Mar. 1969).

Ionospheric recombination phenomena in the intertropical region were studied using model reference heights which vary diurnally, seasonally, and with solar flux and geographic location. It is shown that calculations of airglow emission are sensitive to the variation of reference heights. This applies particularly to the relative amplitudes of evening and morning events. The decrease of F-region height from the expected model value is more directly connected with the cause of recombination events at night than the airglow emission calculated from ionospheric parameters. (auth) (UK)

22998 ELECTRON DENSITY VARIATIONS IN SOUTHERN-HEMISPHERE TOPSIDE IONOSPHERE DURING A MAGNETIC STORM. Katz, Alan H. (Avco Space Systems Div., Lowell, Mass.). J. Atmos. Terrest. Phys., 31: 463-8(Mar. 1969).

Alouette I topside electron density profiles at southern latitudes are compared for magnetically quiet and disturbed periods surrounding the Sudden Commencement magnetic storm of December 17, 1962. Of particular note was the fact that the first post-commencement pass, which was recorded only 18 min after the Storm Sudden Commencement (SSC) at dip angles between 60 and 70°S, showed a large increase in electron density between 67 and 69°S dip, with the percentage increase greater at higher altitudes. It is suggested that, because of the short time interval between the SSC and the observed ionospheric effects, and because the high altitudes were affected more strongly than lower altitudes, the increase at these dip angles can be attributed to additional ionization resulting from precipitating particles in the low-energy range (several eV and above) caused by the contraction of the magnetosphere. (auth) (UK)

22999 COMPUTATION OF MAGNETOSPHERIC CURRENTS CAUSED BY DYNAMO ACTION IN THE IONOSPHERE. van Sabben, D. (Royal Netherlands Meteorological Inst., De Bilt). J. Atmos. Terrest. Phys., 31: 469-74(Mar. 1969).

A method is given for computing the currents which flow along the magnetic field lines through the magnetosphere as a consequence of dynamo action in the ionosphere. It is shown that the computation can be made without knowledge of the real horizontal ionospheric current system, by using the north–south antisymmetrical part of the magnetic potential field of the observed magnetic variation at the Earth's surface. (auth) (UK)

23000 MEASUREMENT OF ELECTRON DRIFT VELOCITIES IN THE NIGHTTIME EQUATORIAL ELECTROJET. Balsley, Ben B. (Jicamarca Radar Observatory, Lima). J. Atmos. Terrest. Phys., 31: 475-8(Mar. 1969).

Very high frequency radar observations of a type of electron-density irregularity in the equatorial electrojet indicate that the nighttime electron flow is in the reverse direction to that during the day. The magnitude of the electron-drift velocity at night is comparable to that during daytime periods, and the reversal occurs typically at about 06.30 hours and 20.30 hours, local time. Data are presented which show the electron-drift velocity as a function of time. Additional aspects of the diurnal variation of the drift velocity are outlined and briefly discussed. (auth) (UK)

23001 RADAR BACKSCATTER AND ROCKET PROBE MEASUREMENTS OF ELECTRON TEMPERATURE ABOVE ARECIBO. Brace, L. H. (Goddard Space Flight Center, Greenbelt, Md.); Carlson, H. C.; Mahajan, K. K. J. Geophys. Res., 74: 1883-5(Apr. 1, 1969).

The rocket profiles of T_e obtained at 0330 and 1530 LT on March 17, 1968, are compared with temperatures derived nearly simultaneously by the radar method at Arecibo Observatory. (W.D.M.)

23002 DISCUSSION OF PAPER BY S. S. RAO AND H. UNZ, "ASYMPTOTIC SOLUTIONS OF WAVES IN INHOMOGENEOUS PLASMA WITH LONGITUDINAL MAGNETIC FIELD". Bennett, J. A.; Chessell, C. I. (Univ. of Melbourne). J. Geophys. Res., 74: 1886-90(Apr. 1, 1969).

Rao and Unz (J. Geophys. Res., 73: 415(1968)) consider a second degree equation describing longitudinal propagation in a gyrotropic plasma and present numerical results that are claimed to be an improvement on the WKB solution. The purpose of this letter is to point out the relation between their method, as far as the second degree equation is concerned, and the method of Erdélyi (1956). A reply by Unz is included. (W.D.M.)

23003 SOLAR FLARES AND MAGNETIC STORM OF MAY 21 TO 28, 1967. Webb, Harold D. (Univ. of Illinois, Urbana). J. Geophys. Res., 74: 1880-2(Apr. 1, 1969).

During the period 1720 UT on May 21, 1967, to 0800 UT on May 28, 1967, signals were received from ATS 1. The Faraday rotation of the signals at 137.35 MHz was measured at approximately 2-min intervals. The Faraday rotation and electron content data are plotted. Several items of interest in this set of data are discussed. (W.D.M.)

23004 RATIO OF THE $O_2(^1\Delta_g-^3\Sigma_g^-)$ (0,0), (0,1) TRANSITIONS. Haslett, James C.; Fehsenfeld, Fred C. (Environmental Sciences Services Administration, Boulder, Colo.). J. Geophys. Res., 74: 1878-9(Apr. 1, 1969).

The $O_2(^1\Delta_g)$ concentration may be studied from the ground by measuring the 1.58-μ emission from the $(^1\Delta_g-^3\Sigma_g^-)$ (0,1) transition, provided one knows the ratio (0,0)/(0,1). It is possible to measure this ratio in the laboratory by measuring the ratio of the intensities of the two emissions. This ratio was measured in the ESSA flowing afterglow system with two photometers. The value obtained was 80 to 1. The estimated uncertainty was 25% and arises primarily from the calibration of the photometers. (W.D.M.)

23005 THERMAL STRUCTURE OF THE IONOSPHERE. Banks, Peter M. (Univ. of California, San Diego, La Jolla). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 258-81(Mar. 1969).

From a large number of rocket, satellite, and ground-based experiments since 1959 it is known that the electron and ion gases of the middle and upper ionosphere are substantially hotter than the neutral atmosphere. At low and midgeomagnetic latitudes the principal heating agent for the ionospheric plasma lies in the excess kinetic energy given to photoelectrons arising from the ionization of the atmospheric gases by solar ultraviolet radiation. Although the photoelectrons lose most of their kinetic energy in the excitation of atomic and molecular gases, a significant amount of energy is given to the ambient Maxwellian electron gas, increasing its temperature above that of the neutral gases. The ion gases, in contrast, appear to be heated almost entirely through the elastic collisions with ambient electrons so that the ion temperature generally lies between the electron and neutral temperatures. The calculation of theoretical temperature profiles has developed into a moderately sophisticated process with a fair degree of correspondence between predicted and observed values for undisturbed geophysical conditions. Current research emphasizes the global aspects of plasma temperatures and the connection between ionospheric and magnetospheric phenomena. However, many of the observed diurnal and seasonal variations in both electron and ion temperatures depend upon the couplings between the neutral and ionized atmospheres, and a complete understanding of all aspects of the ionospheric thermal balance is not possible at the present time. (auth)

23006 SHAPE AND DISPLACEMENT OF NIGHTTIME PRECIPITATION OF AURORAL ELECTRONS. Maneuvrier, Jacques; Maral, Gerard (CNRS, Toulouse). Compt. Rend., Ser. A, B, 268: 274-6(Jan. 20, 1969). (In French).

By means of a registering balloon, x rays induced by bremsstrahlung of precipitating electrons in the high atmosphere were measured. It is shown by means of an apparatus designed for observation in several directions, that there is a displacement near the southeast of the precipitation with a velocity of 280 ± 40 m/s. The dimensions of the precipitation are given. (tr-auth)

23007 HEATING OF THE MAGNETOSPHERIC PLASMA BY ELECTROMAGNETIC WAVES GENERATED IN THE MAGNETOSHEATH. Hasegawa, Akira (Bell Telephone Labs., Murray Hill, N. J.). J. Geophys. Res., 74: 1763-71(Apr. 1, 1969).

After entering the magnetosphere, electromagnetic waves excited in the magnetosheath are absorbed by the magnetospheric plasma either through cyclotron damping at harmonics of the proton and electron gyrofrequencies or through an encounter with the upper hybrid resonance. This absorption of wave energy causes the plasma to be heated. Since the magnetosphere is an inhomogeneous medium for the propagation of ordinary and extraordinary waves, absorption takes place at a spatial location that depends on the wave frequency. An analysis of the passband of extraordinary waves shows that protons are heated rather uniformly throughout the magnetosphere because of cyclotron damping, whereas electrons are most efficiently heated at the plasmapause by wave absorption at the upper hybrid resonance. Results of recent observations of low-frequency electric fields indicate that 100-keV protons can be produced by this mechanism. (auth)

23008 THE OCCURRENCE OF SCINTILLATION-PRODUCING IRREGULARITIES OVER AUSTRALASIA. Singleton, D. G. (Weapons Research Establishment, Adelaide). J. Geophys. Res., 74: 1772-85(Apr. 1, 1969).

An analysis was made of the occurrence of satellite scintillations using observations of the Beacon Explorer satellites at a number of sites throughout Australasia. Time versus latitude contour diagrams of occurrence and mean index for the geomagnetic latitude range 20 to 55° are described. These are compared with similar contour diagrams of the occurrence of the frequency-spreading component of bottomside spread F, sporadic-E ionization, and the ducting and scattering components of topside spread F. Similarities are noted in the occurrence patterns of scintillations and topside scattering on one hand and bottomside frequency spreading and topside ducting on the other. However, these two patterns are complementary in that the occurrence of scintillation and of topside scattering are minimal in the latitude range 30 to 40°, while the occurrence of frequency spreading and topside ducting maximizes in this latitude range. It is inferred that of the F-layer irregularities, those that produce topside scattering are more able to cause scintillation than are those that result in topside ducting and bottomside spread F. It is further postulated that there exists, in the F layer, a continuous spectrum of irregularity sizes, the peak of which shifts from a dimension (normal to the Earth's magnetic field) of less than 1 km at high latitudes to greater than 1 km between latitudes 30 and 40° and back to less than 1 km at the lower latitudes. (auth)

23009 FULL WAVE CALCULATIONS OF GRAVITY WAVE PROPAGATION THROUGH THE THERMOSPHERE. Volland, H. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 1786-95(Apr. 1, 1969).

Full-wave calculations were performed within the frequency range of gravity waves ($10^{-3} \leq \omega \leq 10^{-2}$ sec^{-1}) for a thermospheric model between 150 and 500 km altitude. In this altitude range gravity waves are coupled with heat conduction waves. Reflection, transmission, conversion, and coupling from one wave type into the other one is described by the elements of the scattering matrix. The dependence of these elements on height and angle of incidence is discussed. The transmission coefficients of gravity waves calculated by full-wave theory are compared with simple ray calculations and show that ray treatment is a sufficient approximation for obliquely upward propagating gravity waves and that gravity waves predominate throughout the thermosphere. The thermosphere reacts like a selective filter with respect to upward propagating gravity waves with optimal transmission at $k_x \sim \omega/C$ (ω = angular frequency; C = velocity of sound; k_x = horizontal wave number). (auth)

23010 UPPER ATMOSPHERIC RESPONSE TO TRANSIENT HEATING. Thomas, G. E.; Ching, B. K. (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res., 74: 1796-1811(Apr. 1, 1969).

The response of the upper atmosphere to various forms of time-dependent heating is calculated by use of approximate analytic solutions of the heat conduction equation. Time lags of maximum temperature and density behind peak heating are distinctly different and, for short-duration heating events, are strongly altitude dependent. The time and space characteristics of a one-dimensional heat source that produces a density change consistent with the observed drag on satellites during a geomagnetic disturbance are identified. The desired model for polar substorm heating maximizes in the 140- to 160-km altitude region with an average duration of 4 to 5 hours. The relationship between the amount of heat injected per unit column during a disturbance of maximum geomagnetic index ap is $q \propto (ap)^{1/2}$. This simple relationship suggests a common heating mechanism that is present at all levels of activity. (auth)

23011 AURORAL INFRASONIC WAVES. Wilson, Charles R. (Univ. of Alaska, College). J. Geophys. Res., 74: 1812-36 (Apr. 1, 1969).

The morphology of auroral infrasonic waves at College, Alaska, is related to the temporal and spatial distributions of supersonic auroral motions that develop within the auroral oval during polar magnetic substorms. The breakup phase of the auroral substorm results in the rapid auroral motions that generate the infrasonic waves. Direct observations of infrasonic wave packets from overhead supersonic auroral forms, as well as the comparison of the morphologies of infrasonic waves and auroral motions are used to verify a shock wave model for the generation of auroral infrasonic waves. Electrodynamic drift and joule heating associated with the auroral electrojets in auroras that produce infrasonic shock waves are accepted as the basic processes that generate the initial acoustic pulse within a moving auroral form. (auth)

23012 A CASE OF ARTIFICIAL TRIGGERING OF VLF MAGNETOSPHERIC NOISE DURING THE DRIFT OF A WHISTLER DUCT ACROSS MAGNETIC SHELLS. Carpenter, D. L.; Stone, K.; Lasch, S. (Stanford Univ., Calif.). J. Geophys. Res., 74: 1848-55(Apr. 1, 1969).

A case study is presented of the concurrent and apparently related behavior of four magnetospheric phenomena: (1) whistler "ducts," (2) cross-L drifts of tubes of ionization, (3) an abrupt upper intensity cutoff of ducted whistlers at $f_{H_e}/2$, where f_{H_e} is the minimum electron gyrofrequency along the path, and (4) artificial triggering of vlf whistler-mode noise at $f \sim f_{H_e}/2$. The event occurred on June 17, 1965, near local midnight, and involved the inward drift of a whistler duct through ~0.2 L near L = 3. Triggering of magnetospheric noise by NAA transmissions at 17.8 kHz occurred when the minimum gyrofrequency on the drifting path became twice the NAA frequency. (auth)

23013 UNIQUE FEATURES OF VLF NOISE TRIGGERED IN THE MAGNETOSPHERE BY MORSE-CODE DOTS FROM NAA. Lasch, Steve (Stanford Univ., Calif.). J. Geophys. Res., 74: 1856-8(Apr. 1, 1969).

A study of 1963 vlf data from Eights, Antarctica, verified that triggering of artificial magnetospheric noise by Morse-code dots at 14.7 kHz occurs rarely by comparison to triggering by dashes. In the few cases (~0.3% of all runs) when dots were found to trigger noise, this occurred during strong triggering by dashes. On spectrograms, the dot-produced noises were in each case of a simple falling-tone form. (auth)

23014 AN EFFECT OF A TRANSMITTER FREQUENCY INCREASE ON THE OCCURRENCE OF VLF NOISE TRIGGERED NEAR L = 3 IN THE MAGNETOSPHERE. Carpenter, D. L.; Lasch, S. (Stanford Univ., Calif.). J. Geophys. Res., 74: 1859-62(Apr. 1, 1969).

This note concerns the effect of transmitter frequency on the production in the magnetosphere of artificially stimulated vlf emissions (ASE). The vlf transmitter involved was NAA, which nominally radiates 10^6 watts and is located at Cutler, Maine. The ASE observations were made during the austral winters of 1963 and 1965 at Eights, Antarctica, roughly conjugate to NAA at L ~ 4. (W.D.M.)

23015 AN INTERPRETATION OF OGO LIGHT ION ABUNDANCE MEASUREMENTS. Colin, Lawrence; Dufour, Stuart W.; Willoughby, Dora S. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res., 74: 1863-6(Apr. 1, 1969).

This letter demonstrates quantitatively that suggestions by Taylor et al., (1965) and Bauer (1966) are indeed feasible and that reasonable latitudinal distributions of electron and ion concentrations and temperatures at 1000 km and temperature gradients can be found that are compatible with the OGO measurements and diffusive equilibrium. (W.D.M.)

23016 PRODUCTION OF NO_2^+ IONS IN AIR. Varney, Robert N.; Gunton, Robert C. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). J. Geophys. Res., 74: 1867-9(Apr. 1, 1969).

Two independent experiments were done at Lockheed Palo Alto Research Laboratory that disclose the formation of NO_2^+ ions in air in abundances that mark these ions as the principal ones present. The two experiments are described and results are given. The results imply that the processes that lead to the formation of positive and negative ions of NO_2 in air may need to be considered in quantitative descriptions of the lower ionosphere. (W.D.M.)

23017 RADAR THOMSON SCATTER OBSERVATIONS OF E-REGION TEMPERATURES INTERPRETED AS REVEALING REVERSIBLE HEATING BY ATMOSPHERIC TIDES. Hooke, William H. (Inst. for Telecommunication Sciences, Boulder, Colo.). J. Geophys. Res., 74: 1870-2(Apr. 1, 1969).

Recently, Ward and Perkins (1968) reported two ion temperature height profiles for the E region above Arecibo. They pointed out that while the profiles they observed agreed roughly with that given in the CIRA 1965 model atmosphere, the measured profiles exhibited departures of some ± 50°K from that model profile. Citing Hines (1965), Ward and Perkins attributed the observed temperature maximum near 106 km to an energy source in this region, due to dynamical heating by gravity waves or tidal oscillations, and the observed temperature minimum at 113 km was attributed to an energy sink at this height, perhaps a result of horizontal heat transport. An expanded interpretation of these observations is presented. (W.D.M.)

23018 ANISOTROPIC FLUXES OF ENERGETIC PARTICLES IN THE OUTER MAGNETOSPHERE. Haskell, G. P. (Univ. of Iowa, Iowa City). J. Geophys. Res., 74: 1740-8(Apr. 1, 1969).

Anisotropic fluxes of energetic particles (electrons, $E \gtrsim 50$ keV; protons, $E \gtrsim 830$ keV) encountered by the satellite Explorer 33 in, and immediately adjacent to, the distant trapping region were studied. Attention was given to their location in the frame of reference provided by measurements of the local field. On the day side the flux is peaked at right angles to the field, whereas on the night side it is peaked along the field. Two exceptions to this rule were found, and fluxes of "streaming" particles were found in the magnetosheath, immediately adjacent to the magnetopause. The observations are compared with previous ones and are discussed in the light of current theory. (auth)

23019 MORPHOLOGY OF OUTER RADIATION ZONE ELECTRON ($E > 35$ keV) ACCELERATION MECHANISMS. McDiarmid, I. B.; Burrows, J. R.; Wilson, Margaret D. (National Research Council of Canada, Ottawa). J. Geophys. Res., 74: 1749-58 (Apr. 1, 1969).

A study of outer radiation zone electron intensities at times of magnetic storms is reported. The purpose of the study was to determine how well the intensity at one local time tracks the intensity at the same invariant latitude but at a different local time. Any difference in the intensity time profiles might be expected to yield information about the mechanisms responsible for acceleration of outer-zone electrons, particularly the locations of these mechanisms. The measurements refer to selected periods of several days each and were obtained at altitudes below 3500 km, invariant latitudes in the range 50 to 72°, and at several pairs of local times. At times of magnetic storms the tracking at the two local times is often quite poor at latitudes as low as 55°. For short periods around local midnight and on the morning side of the Earth the intensities observed are appreciably higher than those on the afternoon side. It is concluded from these observations that most of the storm-time acceleration of electrons to energies about 35 keV takes place on the night and morning sides of the Earth. The measurements are used to place an upper limit on stably trapped fluxes in the outer radiation zone that agrees reasonably well with the whistler mode limiting flux calculated by Kennel and Petschek [1966]. (auth)

23020 CONTRIBUTION OF X-RAY AND EUV BURSTS OF SOLAR FLARES TO SUDDEN FREQUENCY DEVIATIONS. Donnelly, Richard F. (Environmental Science Services Administration, Boulder, Colo.). J. Geophys. Res., 74: 1873-7(Apr. 1, 1969).

Recent satellite measurements of x ray and euv radiation of solar flares have been studied to determine, as a function of wavelength, their contribution to E and F1 region ionospheric effects observed by sudden frequency deviations. This study is reported in detail elsewhere (ERL 95-SDL7, USGPO); only the main results are presented here. (W.D.M.)

23021 PHOTOELECTRON FLUX IN THE TOPSIDE IONOSPHERE MEASURED BY RETARDING POTENTIAL ANALYZERS. Rao, B. C. Narasinga; Donley, J. L. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 1715-19(Apr. 1, 1969).

Satellite measurements of suprathermal electrons made at the time of conjugate sunrise indicate that they represent photoelectrons escaping from the production level of about 300 km and moving along the geomagnetic field lines into the conjugate ionosphere. The daytime maximum value of the flux is about 2.5×10^8 electrons cm^{-2} sec^{-1}. The spectral distribution of the flux shows a maximum around 5 to 10 eV. (auth)

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Refer also to abstracts 22532, 23184, 23185, 23240, 23272, and 23790.

23022 (AI-AEC-12744, pp 163-8) ELECTRONIC STRUCTURE OF METALS AND ALLOYS. Breckenridge, R. G.; Barnes, L. J.; Fink, H. J.; Wipf, S. L. (Atomics International, Canoga Park, Calif.).

The recent calculations of van Gelder concerning an upper critical field $H_{c4} > H_{c3}$ for a wedge-shaped specimen are discussed in the light of the surface nucleation field of a slab of finite thickness. Calculations were made as a function of slab thickness d of the critical field at which a second-order phase transition occurs, the point at which vortices nucleate in the slab ($d/\xi = 1.84$), and the size of the unit cell which contains one flux quantum (ξ is the coherence length). Boundary-value solutions of the nonlinear Ginzburz–Landau equations were obtained on the analog computer for both cylindrical and infinite slab geometry. The effects of temperature variations on the differential conductance of superconducting point contacts exhibiting tunneling behavior were studied. A program to measure the thermal diffusivity of selected superconductors below the critical temperature and, if possible, in a magnetic field has been started. (M.H.R.)

23023 (BNL-13502) SOME RECENT AC LOSS MEASUREMENTS IN NORMAL AND SUPERCONDUCTING COILS. Dahl, P. F.; Sampson, W. B. (Brookhaven National Lab., Upton, N. Y.). Mar. 14, 1969. 11p. Dep. CFSTI.

Earlier measurements of ac power losses in coils wound with twisted and untwisted multifilamentary NbTi wires were extended and supplementary loss measurements on coils wound from solid-core normal copper wire are presented. (M.H.R.)

23024 (KFKI-1/1969) NEW EXPERIMENTS ON GIANT ZERO BIAS TUNNELING ANOMALY: EFFECT OF IMPURITY DISTRIBUTION. Mezei, F. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1969. 10p. Dep.

The dynamical resistance $R(V) = dV/dI$ versus V of $Al/Al_2O_3/Al$ tunnel junctions was measured by the standard modulation technique. The fabrication of the junctions is described. The giant zero bias anomaly was found here under entirely different preparation conditions than in previous work. (M.H.R.)

23025 (ORNL-TM-2534) MAGNETIC FLUX FLOW AND SUPERCONDUCTOR STABILIZATION. Quarterly Report, October 1–December 31, 1968. Gauster, W. F.; Horton, J. L.; Kroeger, D. M.; Leichsenring, G. F.; Lubell, M. S.; McDowell, J. D. (Oak Ridge National Lab., Tenn.). Apr. 1969. 61p. Dep. CFSTI.

Maxima in curves of critical current versus temperature at fixed fields have been found to be associated with the peak effect in a Nb–5 at. % Ti strip. The data are in qualitative accord with recent suggestions that a superconductor with $\partial J_c/\partial T > 0$ should show unusual stability. The ratio of the field at the peak to the upper critical field was found to be independent of temperature, having a value 0.84. There is an indication that the dependence of thermal conductivity on temperature is anomalous in the region of the maxima. Flux-jumping experiments have been performed on cylindrical tubes of Nb–Ti alloys believed to possess $\partial J_c/\partial T > 0$ in a reasonable field range. Due to the low J_c in these materials, there was no flux jumping seen at all even where $\partial J_c/\partial T < 0$ for a wide range of dH/dt. Flux jump experiments were made on Nb–25% Zr to see if the onset of "limited instabilities" rather than the flux jump field could be correlated with $H_{fj} = \text{const.}\ [C\ f(T)]^{1/2}$, where C is heat capacity. A "limited instability" region was observed well below the first flux jump field. A low frequency (1.2 Hz) oscillatory voltage was observed on the pickup coil starting at about $1/2$ kG before some of the flux jumps. Additional calculations of the thermal equilibrium states of multistrand compound conductors have been made for various copper to superconductor ratios. These calculations consider the actual heat transfer to the liquid helium bath and the dependence of the superconductor current on magnetic field, temperature, and voltage. The current-voltage characteristics obtained in this way (in contrast to those calculated with simpler models) demonstrate the great variety of possible thermal equilibrium states as indicated by experiments. (auth)

23026 (UCRL-71537) STABILITY OF MULTIFILAMENT SUPERCONDUCTORS. Henning, Carl D. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 1969. 11p. (CONF-690407-10). Dep. CFSTI.

From Symposium on Engineering Problems of Fusion Research, Los Alamos, N. Mex.

The need for higher-current-density magnets has lead to the development of superconductors with inherent stability, i.e., conductors in which flux-jump instabilities have been reduced sufficiently to permit magnet operation beyond the nucleate-boiling stability limit. One method of producing inherent stability is to reduce the diameter and increase the number of niobium–titanium filaments in a composite conductor. Experimental data are presented to confirm the stabilizing effect of such multifilamentation. Short-sample tests are compared to magnet operation and a correlation drawn between filament size and stability as a function of magnetic field. (auth)

23027 FLUX PINNING IN THERMODYNAMICALLY REVERSIBLE TYPE-II SUPERCONDUCTORS. Andronikashvili, E. L. (Inst. of Physics, Tbilisi, USSR). Chivinadze, Dzh. G.; Kerr, R. M.; Lowell, J.; Mendelssohn, K.; Tsakadze, Dzh. S. Cryogenics, 9: 119-22(Apr. 1969).

Pinning studies on single-crystal specimens of $Ta_{70}Nb_{30}$ are described, the near perfect state of the crystals being evidenced by the reversibility of the magnetization curve. (UK)

23028 ULTRASONIC ATTENUATION AT 500 kHz IN SUPERCONDUCTING TIN. Phillips, W. A. (Univ. of Cambridge, Eng.). Proc. Roy. Soc. (London), Ser. A, 309: 259-80(Mar. 25, 1969).

The temperature dependence of the longitudinal ultrasonic attenuation in single crystals of white tin was measured by a resonance technique at a frequency of 500 kHz between 1 and 4.2°K, for propagation along (100) and (001). The resistance ratio of the samples varied from 800 to 30,000 and in all cases the electronic mean free path was smaller than the ultrasonic wavelength. No difference was found between propagation along (100) and (001) in the most heavily doped samples, in contrast to the suggestion of Kadanoff & Pippard, although in this case the normalized attenuation curve lay above the form found by Bardeen, Cooper & Schrieffer. A systematic decrease of attenuation with increasing purity was found, so that in the most pure samples the curve lay well below the B.C.S. form. This effect was more marked for (001) propagation. A simple model is used to calculate the details of elastic scattering in the anisotropic superconductor, and it is shown that scattering across the Fermi surface can account for the lack of any orientational differences. The free path of the excitations is modified by the anisotropy: this brings the theory into very good agreement with the present results, and also increases the theoretical anisotropy of thermal conductivity in tin so as to agree with experiment. Phonon scattering across the Fermi surface is shown to account for the variation of attenuation with purity; the anisotropy of this effect is consistent with the gap anisotropy. (auth) (UK)

23029 TECHNOLOGY OF HARD SUPERCONDUCTORS. Hillmann, Hans (Vacuumschmelze GmbH, Hanau, Ger.). Z. Metallk., 60: 157-65(Mar. 1969). (In German).

Alloys of the Nb–Zr and Nb–Ti systems, as well as the intermetallic compound Nb_3Sn, have proved to be of major importance for the construction of direct current magnets with maximum fields of 100 kOe. Effective pinning of the flux is achieved by introducing so-called pinning centers in the form of sub-bands and normal-conducting precipitates whose size is compatible with the coherency length. The most essential technological measures for obtaining high critical current densities in alloys superconductors are a high degree of cold work and intermittent thermal treatments. (auth)

23030 MECHANISM OF HARDENING SUPERCONDUCTORS. Haasen, Peter (Univ., Goettingen, Ger.). Z. Metallk., 60: 149-56(Mar. 1969). (In German).

The mixed state of type-II superconductors and the way it is influenced by homogeneous and heterogeneous alloying are reviewed. The metallurgical treatment allows a superconductor to carry high currents in high magnetic fields. (auth)

23031 STEADY-STATE STABILITY OF COMPOSITE SUPERCONDUCTORS. Gauster, W. F. (Oak Ridge National Lab., Tenn.). Cryogenics, 9: 136(Apr. 1969).

A composite conductor consists of a superconducting part (often a great number of thin strands) and a nonsuperconducting "stabilizer" (usually copper, but sometimes aluminium or silver) which should be in very good electrical and thermal contact. Stekly and Zar (1965) developed a model for the steady-state stability, based on the dependence of the superconductor current on two variables, the external field H, and the superconductor temperature T. A modification to this simple model is considered in an attempt to improve it quantitatively. (UK)

23032 MICROWAVE TRANSMISSION AND REFLECTION COEFFICIENTS OF THIN SUPERCONDUCTING LEAD FILMS. Lehoczky, Sandor Lajos. Chapel Hill, N. C., Univ. of North Carolina, 1968. 95p.
Thesis.

The microwave transmission- and reflection-coefficient ratios have been measured for pure lead films and lead films plus thin manganese and bismuth overlays at frequencies of 23.89, 37.2, and 69.5 GHz. The results for pure lead films agree well with theoretical transmission- and reflection-coefficient ratios calculated using complex conductivities formulated by Mattis and Bardeen. A comparison of this result with the results of a number of other measurements suggested that the value of the gap indicated by the present measurements probably corresponds to an averaged value of the gap over the Fermi surface in lead. Anomalous changes in the microwave electromagnetic response and in the dc resistance above the critical temperature were observed for each film. These changes were attributed to phase fluctuations near the phase transition. The absence of any structure in the microwave response indicated no precursor absorption as reported by several authors. The deposition of a manganese overlay of approximately 2 Å onto a 150-Å lead film resulted in a 41% reduction in the microwave measured gap. Essentially no change was observed in the dc transition temperature. The measurement of the tunneling voltage as a function of temperature in a "discontinuous" film indicated a depression in the critical temperature by 2°K. This was interpreted as a possible experimental evidence for a recently predicted electrostatic effect in tiny particles. (Disser. Abstr.)

23033 SUPERCONDUCTING PROXIMITY EFFECT OF NIOBIUM. Kircher, Charles John. Evanston, Ill., Northwestern Univ., 1968. 57p.
Thesis.

The proximity effect of a number of nontransition-metal superconductors have been studied previously. In this investigation the proximity effect of niobium, a transition metal superconductor, was studied with a normal metal (copper) and a magnetic metal (nickel). The effect is studied in thin film sandwiches of Nb/Cu and Nb/Ni. The films are deposited by sputtering, one film after the other without breaking vacuum. The second film is deposited on a liquid nitrogen cooled substrate and the resultant sandwich maintained at temperatures below 200°K until after the transition temperature has been measured. This procedure is followed in order to preclude the possibility of metallurgical or chemical interaction at the interface between the two metals. The transition temperature of Nb/Cu and Nb/Ni sandwiches has been obtained as a function of Nb film thickness for thick overlayer films. The Nb/Cu data are in good agreement with both the DeGennes–Werthamer and the Moormann theories. The Nb/Ni data follow the form of the adjustable parameter theory proposed by Werthamer. However, Ni is found to have less effect on Nb than was reported for Pb; a value of the adjustable parameter $\beta = 7$ is obtained for Nb compared to the value $\beta = 43$ for Pb. Possible explanations of the observed behavior are discussed. (Disser. Abstr.)

23034 CONCERNING THE POSSIBILITY OF COMPENSATING HEAT INPUTS INTO LIQUID HELIUM. Keilin, V. E.; Kovalev, I. A. (Atomic Energy Inst., Moscow). Cryogenics, 9: 100-2(Apr. 1969).

The possibility of the partial compensation of heat influxes into liquid helium using return streams of evaporated helium say, in a simple Joule–Thomson cycle is discussed. The elevated pressure helium flow can be cooled to sufficiently low temperatures because of the larger quantity of return flow. Unlike liquefiers and refrigerators whose net refrigeration capacity is correspondingly greater than or equal to the heat load, the "refrigeration capacity" of the devices considered is less than the heat load. Such devices can be considered as "compensators." It is shown that the pressure range needed is of the order of several atmospheres. Some basic design relationships are derived. The experiments carried out confirmed the possibility of the compensation of a considerable part of heat influxes. The experimental arrangement, as well as the main experimental results, are briefly described. Some possible applications of compensators are discussed. (auth)(UK)

23035 ELECTROLYTIC SIMULATION OF THE STEADY MAGNETIC FIELD DISTRIBUTION NEAR SUPERCONDUCTING SURFACES. Slabkii, L. I.; Egorov, A. S.; Kosarin, P. E. (Airforce Engineering Academy, Moscow). Cryogenics, 9: 135(Apr. 1969).

It is stated that the possibility of simulating the distribution of the magnetic field H near the surfaces of superconductors in an electrolytic tank follows directly from the formal analogy between the equations that describe the distribution of the actual field H near the superconductor with the Neumann boundary condition, and the distribution of linear current in an electrolytic bath near dielectrics for a given boundary condition. (UK)

23036 INTERIM VALUES FOR THE VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS OF FLUID ^{4}He BETWEEN 2 AND 50 K. Hanley, H. J. M.; Childs, G. E. (National Bureau of Standards, Boulder, Colo.). Cryogenics, 9: 106-11(Apr. 1969).

The estimation of viscosity and thermal conductivity coefficients of ^{4}He between 2 and 50°K is discussed for densities up to 0.2 g/cm^3. The literature is reviewed and data sources listed. It is obvious that much more data than are available are required. Interim estimates of the coefficients are given based on experimental data, dilute gas kinetic theory, Enskog theory, and corresponding states. (auth) (UK)

23037 NEW MATERIALS AND MORE APPLICATIONS FOR SUPERCONDUCTIVITY. Newhouse, V. L. (Purdue Univ., Lafayette, Ind.); Atherton, D. L. Cryogenics, 9: 80-4(Apr. 1969).

Topics discussed at the Third Annual Applied Superconductivity Conference are briefly reviewed. These included superconducting quantum electronics (flux movement and oscillations in superconducting rings, and Josephson junctions), radiofrequency devices (microwave cavities, antennas, etc.), new materials, and superconductor physics as it affects device performance. The established applications of superconducting magnets to bubble chambers and fusion devices were considered, as well as newer applications to high-speed trains, biophysics, and electron microscopes. One paper described methods of studying the arrangement of fluxons (a quantized magnetic unit of flux) in type-II superconductors. (UK)

23038 MAGNETIC FLUX CONCENTRATION IN BULK HOLLOW SUPERCONDUCTING CYLINDERS. Hlasnik, I.; Cesnak, L. (Electrotechnical Inst., Bratislava). Cryogenics, 9: 95-9(Apr. 1969).

A description is given of the principle of trapping a magnetic field inside a bulk hollow superconducting Nb_3Sn cylinder by removing a magnetized ferromagnetic core from the cylinder. The concentration of the trapped field can be extended by applying the described principle to more than one cylinder and core and/or by suitable shaping of the cylinder and the core. Also described are the results obtained by using this method to increase the magnetic induction of a superconducting solenoid, and to concentrate the magnetic field of an electromagnet by means of two concentric cylinders. (auth) (UK)

23039 THE SUPERCONDUCTIVE TRANSITION TEMPERATURE OF BINARY AND TERNARY SOLID SOLUTIONS IN THALLIUM. Hasse, J.; Reichert, V. (Univ., Karlsruhe, Ger.). Z. Phys., 221: 471-9(1969).

The transition temperatures of various binary alloys and of ternary alloys in the system $Tl\ Hg_x\ Sn_y$ were investigated. By analyzing the results different anisotropy parameters were obtained. This was explained by a nonlinear valence dependence of the transition temperature, which can be caused by changes in the topology of the Fermi surface. (auth)

23040 NEUTRON-DIFFRACTION STUDY OF THE LOW-TEMPERATURE TRANSITION IN UP. Heaton, L.; Mueller, M. H.; Anderson, K. D.; Zauberis, D. D. (Argonne National Lab., Ill.). J. Phys. Chem. Solids, 30: 453-4(Feb. 1969).

UP was reinvestigated at lower temperatures with neutron diffraction. The original sample was recooled to liquid helium temperatures; an increase in the intensities of the magnetic reflections of the type-1 magnetic structure was noted. Measurements of the integrated intensity of the magnetic (110) reflection were made during 65th heating and cooling. The transition occurred over an interval of less than 2°K at a temperature of 25 ± 1.0°K. (UK)

23041 SUPERCONDUCTING Zn-Cd FILMS FOR TEMPERATURE PULSE DETECTION BELOW 0.8 K. Ackerman, C. C.; Allen, L. D.; Overton, W. C. (Los Alamos Scientific Lab., N. Mex.). Cryogenics, 9: 63-4(Feb. 1969).

A Zn–Cd film was developed for heat pulse experiments in ^{3}He–^{4}He crystals, in preference to carbon, because the input temperature excursions, required in the ^{4}He heat pulse experiments to obtain a satisfactory received temperature pulse on a carbon receiver, were close to and sometimes exceeded the value where distortions of the received pulse were observed. Also, the large acoustic mismatch between the carbon/helium interface limited the pulse rise times to a few microseconds; Zn–Cd films have a much lower Debye temperature than carbon, and hence the acoustic mismatch at the helium–detector interface should be considerably reduced with these films. The preparation and superconducting transition characteristics are described. (auth) (UK)

23042 COMPOSITION AND SUPERCONDUCTING PROPERTIES OF Au-Pb FILMS. Leder, L. B. (Ford Scientific Lab., Newport Beach, Calif.). Cryogenics, 8: 364-72(Dec. 1968).

Superconducting Au–Pb films were prepared by evaporation of Au first, Pb first, and co-evaporation. X-ray diffraction showed the formation of three compounds, and in no case was a single phase film formed. Complete compound formation took about 2 days at room temperature, and only 2 to 3 hr at 100°C. The transition temperature decreased with increasing Au content, but at a different rate for the three formation methods. The layered films exhibited maximum resistance and transition width and minimum critical current ($T_c - T = 0.1$ K) at 25 at. % Au, while the co-evaporated films showed these maxima and minima at 33⅓ at. % Au. (auth) (UK)

23043 SUPERCONDUCTING MACHINES. Appleton, A. D. (International Research and Development Co. Ltd., Newcastle-upon-Tyne, Eng.). Sci. J., 5: 41-6(Apr. 1969).

It is stated that the whole field of electrical machinery is likely to be revolutionized before 1980 by the introduction of motors and generators incorporating superconducting materials. A large superconducting motor driving a pump in a British power station is about to undergo trials. (auth) (UK)

23044 EXPERIMENTS WITH SUPERCONDUCTING MAGNETS. Lange, F. (Institut fuer Tieftemperaturphysik, Dresden). Monatsber. Deut. Akad. Wiss. Berlin, 10: 872-8(1968). (In German).

A series of practical studies were made with seven superconducting coils, whose physical principles were previously reported. The characteristics of the coils are tabulated. The experiments showed that the training effect is closely connected with the degradation effect. Three types of cryostats to be used with these coils are described. The times necessary for putting the coil into operation and the corresponding loss in coolants were determined for one coil. (J.S.R.)

23045 ATTAINABILITY OF ABSOLUTE ZERO. Semenchenko, V. K. Zh. Fiz. Khim., 43: 257-9(Jan. 1969). (In Russian).

Analysis of the conditions of thermodynamic equilibrium of saturated stable phases shows that this equilibrium can exist by inequality of the characteristic generalized forces in both phases, this being confirmed by superconductor–conductor equilibrium where ΔH reaches, in certain cases, 10^5 Oe. As far as the thermodynamics of superdiamagnetics (superconductors) and supercaloric phases ($S = 0$, $T = 0$) are special cases of the theorem concerning saturated stable states, supercaloric phases can be obtained by the action of other generalized forces (e.g., p or H) on phases with $T \neq 0$. However, in cases when $(\partial S/\partial p)_T = -(\partial V/\partial T)_p$ with $T \rightarrow 0$ become negative (^{4}He, Si, Ge, and Sn), this hinders the obtaining of supercaloric phases. It is possible that, analogous to superconductors, there exists a limited number of supercaloric substances. (tr-auth)

23046 ON THE MOESSBAUER EFFECT OF CHALCOPYRITE. Raj, D.; Puri, S. P. (Univ. of Roorkee, India). Nuovo Cim., 60B: 261-4(Apr. 11, 1969).

The reported Mössbauer spectra of the ^{57}Fe 14.4 keV γ-rays in $CuFeS_2$ of Aramu et al., are criticized and shown to originate from FeS_2 (pyrite) association of the studied sample. In addition, the hypothesis of the iono-covalent resonant structure as advanced by them is shown to be untenable considering the observed values of quadrupole splitting. (auth)

23047 DETERMINATION OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF DILUTE Ti–Rh-ALLOYS BY SPECIFIC HEAT MEASUREMENTS. Danner, Siegfried; Dummer, Gerald (Univ., Karlsruhe, Ger.). Z. Phys., 222: 243-52 (1969). (In German).

The specific heats of Ti–Rh alloys were measured between 0.4 and 4°K for Rh concentrations between 0 and 3 at.%. The measurements were carried out in a simple ^{3}He cryostat. The transition temperature and the electronic specific heat are increasing functions of the Rh concentration. In quenched alloys the α' phase can be stabilized up to an average Rh concentration of 2.5 at.% for the whole sample. (auth)

23048 LOW TEMPERATURE SETUP FOR ELECTRON IRRADIATION AND SUBSEQUENT PHOTOCONDUCTIVITY STUDIES OF SEMICONDUCTORS. Vajda, P.; Lori, J. (Chalk River Nuclear Labs., Ont.). Rev. Sci. Instrum., 40: 690-7(May 1969).

A cryostat is described for irradiations with electrons at liquid helium temperatures and subsequent photoconductivity and infrared absorption studies in the range from 20 to 400 K. Heat is removed from the sample by conduction through a copper tail touching the bottom of the liquid helium container. A mechanical switch enables the thermal separation of the sample assembly from the helium bath during the annealing studies. A rotatable outer-tail piece permits irradiation with electrons through aluminum windows avoiding damage to the optical NaCl windows. The beam dosimetry and monitoring equipment are described in detail. (auth)

23049 HEAT CAPACITY OF hcp AND bcc SOLID ^{3}He. Sample, H. H.; Swenson, C. A. (Ames Lab., Iowa). Contract W-7405-eng-42. Phys. Rev., 158: 188-99(June 1967). (IS-1454).

Experimental data are presented for the heat capacity of hcp ^{3}He at five molar volumes (19.05 to 11.42 cm^3) and for bcc ^{3}He at four molar volumes (20.18 to 23.80 cm^3). These data extend from the true T^3 region ($T/\Theta_0 < 0.03$) to the melting line in all cases with sufficient precision (at least 1% in Θ_D) so that the volume dependence of both Θ_0 and the reduced Θ-versus T (Θ/Θ_0-versus-T/Θ_0) relationship can be determined. In general, when a comparison is made with other ^{4}He data, $\theta_{03}/\theta_{04} = 1.18$. The quantity $\gamma_0 = -\,d \ln \Theta_0/d \ln V$ varies from 2.6 to 2.0 for the hcp data with decreasing molar volume, while $\gamma_0 = 2.2$ for the bcc phase. The changes in the shapes of the reduced Θ-versus-T curves for the hcp phase can be understood in terms of a slightly temperature-dependent Grueneisen constant γ, the ratio γ/γ_0 being independent of volume to a first approximation and increasing to approximately 1.07 at $T/\Theta_0 = 0.12$. The shapes of these reduced Θ-versus-T curves at the smallest molar volumes are almost identical for hcp ^{3}He and for our one hcp ^{4}He run, and agree with comparable previous data at relatively high temperature. These shapes resemble closely the zero-pressure data for argon and krypton and the theoretical calculations of Horton and Leech. The bcc ^{3}He data can be represented quite precisely as the sum of a Debye-like term [involving $\Theta_0(V)$] and an exponential Schottky-like term [involving a characteristic temperature $\phi(V)$]. When compared with the hcp data, the bcc data cannot be explained solely in terms of conventional lattice dynamics. (auth)

23050 SIZE EFFECTS IN SUPERFLUID HELIUM II. I. EXPERIMENTS IN POROUS SYSTEMS. Guyon, E.; Rudnick, I. (Univ. of California, Los Angeles). J. Phys. (Paris), 29: 1081-95(Nov.-Dec. 1968).

The properties of the superfluid phase of liquid helium are modified by size effects. Experiments are described on helium contained in very fine compressed powders (~100 to 10^4 Å): lowering of the onset temperature for superfluidity, T_0, and superfluid properties for $T < T_0$: critical flow rate, specific heat, superfluid fraction. These last data are obtained from the measurement of the hydrodynamic sound velocity that propagates in such porous systems: 4th sound. The techniques of the measurements and the physical properties of 4th sound are presented. A discussion of the results is presented in analogy with the study of the proximity effect in superconductors. (auth)

23051 HEAT OF MIXING AND GROUND-STATE ENERGY OF LIQUID ^{3}He–^{4}He MIXTURES. Seligmann, P.; Edwards, D. O.; Sarwinski, R. E.; Tough, J. T. (Ohio State Univ., Columbus). Phys. Rev., 181: 415-23(May 5, 1969).

The heat evolved when ^{3}He is added to liquid ^{3}He–^{4}He mixtures at the saturated vapor pressure has been measured for temperatures in the region of 0.05°K. The starting concentrations varied between zero and six atomic percent of ^{3}He. Since the variation of the energy with temperature (the specific heat) is known, the experiments give the ground-state energy and the ^{3}He and ^{4}He chemical potentials at 0°K as a function of concentration. The measurements were made in a calorimeter connected by a wire of high thermal resistance to a dilution refrigerator operating at ~0.02°K. The ^{3}He was added through a long tube containing thermal anchors connected to the refrigerator. The results give the difference in binding energy for one ^{3}He atom in ^{4}He relative to pure ^{3}He as $(E_3 - L_3^0)/k_B = (0.312 \pm 0.007)$ deg K, in excellent agreement with the theoretical value of Massey and Woo. The concentration dependence of the energy and chemical potentials agrees with predictions using the Bardeen, Baym, and Pines empirical interaction. The osmotic pressure in a saturated solution at 0°K is found to be (17.8 ± 0.9) mm Hg. (auth)

23052 SOUND PROPAGATION IN LIQUID ^{4}He. Abraham, B. M.; Eckstein, Y.; Ketterson, J. B.; Kuchnir, M.; Vignos, J. (Argonne National Lab., Ill.). Phys. Rev., 181: 347-73(May 5, 1969).

Measurements of the attenuation of sound in liquid ^{4}He down to 0.1°K have been performed at 12, 30, 36, 60, 84, 90, 108, 132, 150, and 208 MHz. Measurements of the temperature dependence of the velocity of sound were made at 12, 36, 60, and 84 MHz. These data are compared with recent theoretical work, particularly that of Khalatnikov and Chernikova. The attenuation data agree well with theory in the vicinity of the peak in the attenuation near 1°K but do not agree elsewhere, the observed attenuation being greater than that predicted by theory. The temperature dependence of the velocity at low temperatures is found to be less than that predicted by theory, while the frequency dependence of the velocity (at finite temperature) is opposite to that predicted by theory. (auth)

23053 THE EFFECT OF FREE RADICALS ON SUPERCONDUCTORS. NITRIC OXIDE ON ALUMINUM. Shimshick, E. J.; McConnell, H. M. (Stauffer Lab. for Physical Chemistry, Stanford, Calif.). J. Amer. Chem. Soc., 91: 1854-5(Mar. 26, 1969).

For odd-electron free radicals, the absence of conductive conjunction should manifest itself by a strong dispersion of the superconducting transition temperature, since localized unpaired spins can break up the Cooper pairs of the superconducting state. This absence of conductive conjugation is demonstrated here for nitric oxide deposited on superconducting aluminum films. Different experimental setups were used and the various results are interpreted. (M.H.R.)

23054 THERMAL CONDUCTIVITY OF PURE TYPE-II SUPERCONDUCTORS IN THE MIXED STATE. Maki, Kazumi (Institut Max von Laue, Garching, Ger.). Phys. Kondens. Mater., 8: 305-11(1969).

The electronic contribution to the thermal conductivity in a pure type-II superconductor in a field immediately below H_{c2} is reconsidered. In a pure type-II superconductor the electron scattering due to the electron-phonon interaction becomes of importance. The inclusion of the electron–phonon interaction into the theory gives rise to a sharper drop of the thermal conductivity in a field slightly below H_{c2}. Also the problem of the diamagnetization factor is discussed. (auth)

23055 A STUDY OF THE GROUND-STATE PROPERTIES OF LIQUID ^{4}He. Mihara, Norihiko. Seattle, Univ. of Washington, 1968. 122p.

Thesis.

A study of the ground state properties of liquid ^{4}He is made using sum rules for the spectral function $S(k,\omega)$ associated with the density-density correlation function. A sharp resonance assumption for $S(k,\omega)$ yields the well-known results obtained by Feynman for the excitation energy in liquid ^{4}He as well as an equation for determining the liquid structure factor $S(k)$ from a knowledge of the interparticle potential between helium atoms. This approximation for $S(k,\omega)$, which is based on both experimental and theoretical considerations, is shown to be inadequate for describing liquid helium and, in fact, inconsistent for any system. The inconsistencies are demonstrated explicitly for calculating the radial distribution function, and a modification is made to the equation for $S(k)$ which is equivalent to introducing a width in $S(k,\omega)$. Even though the exact nature of the width is not specified, the liquid structure factor $S(k)$ is uniquely determined by a nonlinear integral equation involving the interatomic potential. The modified equation for $S(k)$ produces Bogolyubov's perturbation theory results in the low-density and weak-interaction limit, and for sufficiently strong interactions, numerical solutions which exhibit oscillations about unity similar to those observed experimentally. In order to obtain a comparison with the experimental results for liquid ^{4}He, a sum of two Yakawa potentials with the parameters adjusted to best fit the Lennard–Jones potential is used to represent the interaction between helium atoms. The integral equation is solved numerically to give $S(k)$ as a function of the density. These solutions are then used to calculate the ground-state energy per particle E/N, pressure P, and sound velocity c. At the equilibrium density, i.e., the density for which E/N is a minimum, the theoretical predictions for the liquid structure factor and the thermodynamic parameters are found to be in quite good agreement with experiment. (Diss. Abstr.)

23056 CAUSE OF EXPLOSIONS IN REACTOR CRYOSTATS FOR LIQUID NITROGEN. Chen, C. W.; Struss, R. G. (Ames Lab., Iowa). Cryogenics, 9: 131(Apr. 1969).

A mild explosion that occurred recently in a typical reactor cryostat under carefully controlled conditions is described. A subsequent analysis of this incident produced some valuable information on the nature of the explosion. Apparently it was caused by oxygen that condensed into the cryostat during a part of the experiment, and subsequently converted into ozone and/or an explosive nitrogen oxide. (UK)

23057 LIQUID-SOLID PHASE TRANSITION IN ^{3}He–^{4}He MIXTURES. Tedrow, P. M.; Lee, D. M. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 181: 399-415(May 5, 1969).

Measurements on the liquid–solid phase transition of ^{3}He–^{4}He mixtures have been performed by means of a strain-gage technique. It was found that the freezing curves of mixtures with initial concentrations of greater than 5% ^{3}He merged into a common curve with negative slope in the P–T plane. This curve is interpreted to be a three-phase equilibrium line or univariant involving the coexistence of bcc solid helium and the two phase-separated liquids, one rich in ^{3}He and the other rich in ^{4}He. A number of other univariant lines involving these and other phases of helium have also been observed. Univariants intersect at quadrupole points which are defined as points where four phases coexist. A quadrupole point has been observed in these experiments involving coexistence of bcc solid helium, hcp solid helium, and the two phase-separated liquids at a temperature T = 0.37°K and a pressure P = 26 atm. The data are discussed in terms of a three-dimensional phase diagram which is consistent with the Gibbs phase rule and with the results obtained by other investigators. (auth)

23058 ESCAPE OF IONS TRAPPED IN ROTATING SUPERFLUID HELIUM BELOW 1°K. Douglass, R. L. (American Univ., Beirut). Phys. Lett., 28A: 560-1(Jan. 27, 1969).

Results are presented of direct measurements confirming the anomalous increase in negative ion escape rates from vortex lines at temperatures below 1°K. (auth)

23059 DETERMINATION OF THE GINZBURG-LANDAU PARAMETERS OF AN INDIUM-LEAD ALLOY BY A STEADY-STATE CALORIMETRIC TECHNIQUE. Zoller, P.; Dillinger, J. R. (Univ. of Wisconsin, Madison). Phys. Lett., 28A: 682-3(Feb. 24, 1969).

Measurements of the Ginzburg–Landau parameters κ_1 and κ_2 of an In–7.3 at. % Pb alloy by a steady-state calorimetric technique show poor agreement with existing theories. (auth)

23060 EFFECT OF ANNEALING ON THE SUPERCONDUCTING TRANSITION TEMPERATURES OF Nb_3Al AND Nb_3Al ALLOYS. Sahm, P. R.; Pruss, T. V. (Radio Corp. of America Labs., Princeton, N. J.). Phys. Lett., 28A: 707-8(Feb. 24, 1969).

Arc-melted Nb_3Al and alloys in which Al was replaced by As, Ga, and GaAs showed optimal T_c's after annealing between 600 and 700°C. Lattice constant measurements suggest this to be the result of improved stoichiometry. (auth)

23061 EVIDENCE THAT THE TRANSITION AT H_{c2} IN NIOBIUM MAY NOT BE SECOND ORDER NEAR ABSOLUTE-ZERO TEMPERATURE. Williamson, S. J. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Lett., 28A: 665-6(Feb. 24, 1969).

The anisotropy of H_{c2} for single-crystal niobium was measured for $0.4°K \leq T \leq 4.2°K$. A continuation of the observed trend to lower temperatures would imply that the transition near absolute zero is not second-order for all field directions. (auth)

Plasma and Thermonuclear Physics

23062 PLAZMA VE VESMIRU A LABORATORI. (Plasma in the Universe and the Laboratory). Kleczek, Josip. Praha, Academia, 1968. 329p.

Discussions on the motion of confined particles and on hydromagnetics are followed by chapters on wave propagation in plasma, plasma stability, plasma radiation, and on plasma in the solar system, in galaxies, and in deep space. There are many technical illustrations and equations, with a bibliography of 35 references, mostly books, about half of which are in English. (TTT)

Confinement and Heating

23063 (CEA-R-3568) STUDY OF THE TEMPORARY CAPTURE OF AN ELECTRON BEAM IN MAGNETIC MIRROR CONFIGURATION. Gourden, Jean-Jacques (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). Dec. 1968. 80p. (In French). (EUR-3870). Dep.

A method of injection is studied which is intermediate between the purely transverse injection used in MM II and the longitudinal injection used in CAPEL. The investigation of the conditions of injection of an electron beam has shown the possibility of capturing temporarily a beam approximately 1 cm in width. The mean length of the captured trajectories is about fifty meters. A uniform perturbation of the magnetic field which destroys the axial symmetry does not appreciably modify the length of captured trajectories. This method of injection, called "conical", is interesting because a large proportion of the injected beam is captured (about 80%), and this capture is obtained with injection conditions that are not critical. (auth)

23064 (IPP-1/92) PLASMA LOSSES IN A TOROIDAL THETA PINCH WITH SUPERPOSED HELICAL HEXAPOLE ($n = 4/3$). Lotz, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov. 1968. 39p. Dep.

A toroidal theta pinch discharge with superposed helical hexapole field is investigated. The characteristic data of the discharge are the same as reported in IPP 1/82: major diameter 52 cm, minor inner diameter of the vacuum vessel 6.0 cm, maximum theta pinch field between 10.5 and 21 kG, rise time (quarter cycle) 3.0 μs, maximum temperature between 40 and 100 eV, maximum density between 1 and 3×10^{16} cm^{-3}, minimum plasma radii between 0.5 and 1.0 cm, beta values between 0.3 and 1.0. The pitch-angle between a hexapole wire and the minor axis is 11°, thus a hexapole wire passes $4/3$-times around the minor axis when circling around the major axis once (the rotational number $n = 4/3$). Plasma temperature, density, and radius turned out to be approximately the same as in the nonhelical case. The plasma loss rates are determined by measuring the particle density; on the mean they are (34 ± 10)% smaller than those with nonhelical hexapole and are virtually independent of the combination of parameters used. Within experimental error, the losses can be described as cusp losses with a cusp slit width of 0.54 ion gyro radii or as resistive losses with a diffusion coefficient 1.7 times the classical value. Bohm diffusion is not consistent with the measurements, the losses are up to 5 times smaller than those predicted by the Bohm formula. The machine is being converted to a fast stellarator with higher helical pitch (pitch-angle 21°, rotational number $n = 8/3$), thus the diameter of the (vacuum-field) separatrix will be doubled for the same value of the hexapole current and will be of the order of the plasma diameter. (auth)

23065 (IPP-2/73) A CO_2-GAS LASER FOR CONTINUOUS HEATING OF THE PLASMA SOURCE IN THE "WENDELSTEIN"-STELLARATORS. Lipa, M. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov. 1968. (In German). Dep.

A CO_2-gas laser that radiates about 150 watts in the wavelength region around 10.6 μm has been built. This light power is high enough to heat the plasma source—a tantalum sphere of 3 mm diameter—up to an equilibrium temperature of 2600°K. (auth)

23066 (IPP-4/56) DOCUMENTATION OF FUSION TECHNOLOGY. Mantel, J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1968. 46p. Dep.

The growing spate of information in fusion technology has created the need for documentation in this field. This documentation covers specific problems which do not arise in documentations of physics or special fields such as plasma or vacuum physics. This is due to the fact that, although fusion technology is a relatively narrow field, the relevant information is spread over many thousands of periodicals or several million papers annually. The documentation reviews about 80 periodicals, 10 abstract journals and many reports. This paper analyzes the practice gained in Garching, compares documentation methods, and explains the documentation philosophy. An abstract of the latest copy (September 1968) is included as an appendix. (auth)

23067 BEAM-INJECTED AND LORENTZ-TRAPPED HOT ELECTRON PLASMA. Perkins, W. A. (Univ. of California, Livermore). Phys. Fluids, 12: 713-19(Mar. 1969).

Neutral-atom injection with Lorentz trapping is one of the most popular and successful methods of forming a "hot ion plasma." It is suggested here that one could form a "hot electron plasma" by injecting ions with megaelectron volt energies and using Lorentz trapping. For example, build-up calculations indicate that one could form in a mirror machine a 15-keV "hot electron plasma" with a density of 10^9 cm^{-3} by using a 50-μ A beam of H_2^+ at 60 MeV. The H_2^+ beam would be sent through a gas cell or foil to obtain some 30 MeV H^0 atoms by dissociation. The H^0 would then pass through the magnetic confinement field and some 15-keV electrons would be trapped by Lorentz ionization of excited H^0. If the background gas pressure is below 10^{-6} torr, electron–electron scattering will determine the containment time for $n \approx 10^9$ cm^{-3}. Neutralization of the hot electrons can be accomplished by ionization of the residual gas as the ionization time constant is much shorter than the gas-scattering time constant. Since typical scattering times are many seconds, dc operation is preferable. If one can obtain the necessary combination of ion energy and confining magnetic field strength, Lorentz electron stripping from the H^- or He^- ground state can result in very high trapping efficiencies and higher plasma densities. Some advantages and uses for beam-injected and Lorentz-trapped hot electron plasmas are discussed. (auth)

23068 LOW-β PLASMA PENETRATION ACROSS A MAGNETIC FIELD. Fried, Burton D. (Univ. of California, Los Angeles. TRW Systems Group, Redondo Beach, Calif.); Ossakow, Sidney. Phys. Fluids, 12: 702-6(Mar. 1969).

Self-consistent solutions for the problem of a collisionless plasma streaming across a magnetic field whose dimensions are small compared to $(r_{ce}r_{ci})^{1/2}$ show that the electrons can accompany the ions across the field (over distances large compared to r_{ce})

provided $\omega_{ce} < \alpha\omega_{pe}$, where $\alpha \leq 1$ is a function of the electron distribution function ($\alpha = 1$ when the electron thermal velocities are neglected). This appears to explain the threshold, $\omega_{ce} \simeq 0.9\ \omega_{pe}$, observed in recent experiments on plasma penetration across a radial magnetic field. (auth)

23069 ION HEATING IN A VERY FAST THETA PINCH. Wilhelm, Rolf (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Phys., 222: 208-21(1969). (In German).

In a theta pinch with an extremely fast rising magnetic field (dB/dt 10^{11} G/sec), a strong compression wave is produced in an initially fieldless low-density deuterium plasma. Assuming simple plasma models, a high-energy gain of the ions is expected already during the implosion of the plasma. In agreement with these calculations for a filling pressure of 20 μD_2, a mean ion energy of 1 to 2 keV is determined from the first neutron emission at the end of the implosion, only 150 nsec after ignition. Decreasing the initial pressure to 10 μD_2 does not cause any further increase of the achieved ion energy. This limitation of the ion heating is explained by a strong broadening of the current carrying layer at low densities which is observed by magnetic probe measurements. In the adiabatic compression, the mean ion energy attains values of several keV. During the first part of this phase, the energy distribution function of the ions is found to be essentially anisotropic, and monoenergetic rather than Maxwellian. (auth)

23070 DIFFUSION IN TOROIDAL PLASMAS WITH RADIAL ELECTRIC FIELD. Stringer, T. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Rev. Lett., 22: 770-4(Apr. 14, 1969).

The equilibrium of an axisymmetric toroidal plasma is analyzed. In the resistive regime the diffusion rate derived by Pfirsch and Schlüter is modified when the plasma rotates about its minor axis because of electric drift. In the weakly collisional regime the electron diffusion rate is greater than that derived by Galeev and Sagdeev, except in the ambipolar condition where the diffusion rate is comparable with theirs. (auth)

23071 CROSS-FIELD PLASMA TRANSPORT IN A MAGNETICALLY CONFINED LOW-BETA COLLISION-DOMINATED PLASMA. Courville, George Eugene. Hoboken, N. J., Stevens Inst. of Tech., 1968. 145p.

Thesis.

Measurements of plasma loss transverse to a uniform magnetic field were made with a potassium Q machine for the parameter range $2050 < T < 2350°K$, $10^{10} < n < 10^{11}$ cm^{-3} and $1000 < B < 4000$ gauss. Plasma losses are attributed to two mechanisms: M I, and E × B radial drift due to azimuthal temperature gradients at the hot ionizer plate, and M II, a wave-driven loss that has been identified as being due to a collisional drift-wave instability. (Diss. Abstr.)(TSS)

23072 CRITICAL PRESSURE IN AN AVERAGE MAGNETIC WELL. Andreoletti, J. (EURATOM-CEA, Fontenay-aux-Roses, France). Plasma Phys., 10: 987-91(Nov. 1968). (In French).

The consideration of "compensated" interchange motions leads to the estimate of a critical pressure in a mean magnetic well with closed lines. A corresponding expression is then obtained for the case of a system with magnetic surfaces, where it is assumed that a small longitudinal resistivity annihilates the stabilizing effect of the toroidal shear. Finally a method is discussed for deriving mean magnetic wells from true magnetic wells. (auth) (UK)

23073 NUMERICAL SOLUTION OF THE LORENTZ FORCE EQUATION BY HIGH-ORDER INTEGRATION. Faulkner, James E. (Aerojet-General Corp., San Ramon, Calif.). Phys. Fluids, 12: 940-2(Apr. 1969).

Methods are developed to generate a Taylor series expansion to any desired order for the Lorentz force equation in order to follow a charged-particle orbit for long periods of time. These methods are applied to a magnetic well geometry. (auth)

23074 SIMILITUDE FOR SHOCK-WAVE INITIATED FLUX COMPRESSION. NiCastro, James (Sandia Lab., Albuquerque, N. Mex.). Phys. Fluids, 12: 769-75(Apr. 1969).

An investigation and extension of similarity concepts have been undertaken for describing shock-initiated flux compression devices. The similarity equations are developed for finite variable conductivities. Compatibility of an induced homology for the preshock magnetic field is seen to give rise to a flux compression constraint. This constraint relates the shock speed to the growth rate of the field and the homology characterizing preshock density gradients. Use of a nonstatic piston in similarity problems is questioned on physical grounds. Numerical examples are calculated for field compression with an infinite postshock magnetic Reynolds number in order to obtain sample postshock field profiles. Analytic solutions can be obtained when the dimensionless Alfvén velocity $B^2/R \lesssim 1$. Some flux slipping appears to be required to obtain nonsingular solutions. (auth)

23075 AMBIPOLAR DIFFUSION IN RADIO-FREQUENCY-EXCITED MAGNETOPLASMAS. Robertson, Harry S.; Herring, John J. (Univ. of Miami, Coral Gables, Fla.). Phys. Fluids, 12: 836-9(Apr. 1969).

A theoretical analysis of ambipolar diffusion in electrodeless, weakly ionized, collision-dominated, radio-frequency-excited magnetized plasmas reveals an essential dependence of the steady-state density profile on the electron-density dependence of the net volume-ionization rate. In particular, if and only if the ionization rate is simply proportional to the electron density, the particle fluxes are ambipolar; otherwise, there exist divergenceless current cells for which the axial and radial current densities are not everywhere zero. Experimentally, it was found impossible to produce such a uniform plasma in argon, where the ionization process is two stage, and goes as n^2, whereas the same method of excitation easily yielded a uniform cesium vapor plasma, for which the ionization process is proportional to n. (auth)

23076 MOTION OF A NEWLY FORMED PLASMA IN A MAGNETIC FIELD. Zinn, John (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 12: 840-3(Apr. 1969).

Analytic expressions are derived for the motion of a hypothetical collisionless plasma which is created with isotropic velocities at time $t = 0$ within a uniform magnetic field. The electron and ion masses are assumed to be equal. It is found that the tendency of the particle magnetic moments to cancel the original B field is counteracted by macroscopic currents induced in the plasma through the changing field. The equations for the B field variation and for the macroscopic motion resemble the magnetohydrodynamic equations, with superimposed oscillatory terms of frequency ω and $(\omega_p^2 + \omega^2)^{1/2}$. (auth)

23077 FURTHER STUDIES OF EXCITATION–HEATING OF IONS. McNally, J. Rand Jr. (Oak Ridge National Lab., Tenn.). Plasma Phys., 10: 903-10(Oct. 1968).

Further studies were made of long magnetically confined vacuum carbon arcs in order to elucidate a previously proposed energy-pumping mechanism called "excitation–heating," explaining a drastic departure from thermodynamic equilibrium ($T_i \sim 100\ T_e$). The ion densities of C^{2+} and the metastable C^{2+*} on which the mechanism depends, as well as of C^{3+}, were measured by vacuum ultraviolet absorption spectroscopy, and the results support the concept of excitation–heating. Mass spectrometric studies of the arc periphery also showed C^{2+} and C^{3+} as the dominant ions. The Massey–Hasted adiabatic maximum criterion and the theory of Rydnik and Yavorskii are applied to the near-resonance intermediate reaction step $C^{2+*} + C^{2+*} \rightarrow C^{2+\prime} + C^{2+} + 0.29$ eV ($\rightarrow C^{2+} + C^{2+} + 13.0$ eV) and predict the large reaction cross section at fairly low collisional energies needed by the excitation–heating process. (auth) (UK)

Diagnostics

Refer also to abstract 22883.

23078 (AD-672813) SPACE–TIME RESOLVED MACH–ZEHNDER INTERFEROMETER MEASUREMENTS OF CROSS-SECTIONAL ELECTRON DISTRIBUTION IN THETA-PINCH PLASMA. Roberts, Howard N.; Dougal, Arwin A. (Texas Univ., Austin. Electronics Research Center). Apr. 22, 1968. 138p. (AFOSR-68-0878). CFSTI.

In theta-pinch deuterium plasmas instabilities are studied extensively and related to end losses, axial density minima, and neutron production. Nonrotating flute and flute-like instabilities form in the first quarter cycle in all reverse-biased plasmas. Mode numbers and evolution characteristics are highly dependent on reverse bias strength. Kink instabilities rotating near 1 rev/μsec always develop near or after the time of peak-B for −2.7 to −4.0 kG and in certain cases for −1.3 kG bias. For 0.04 to 0.10 torr a Mach–Zehnder interferometer illuminated by a 175-MW (6943 A) giant-pulse ruby laser and axially coupled to the plasma yields space–time resolved cross-sectional electron distributions. A digital computer technique employs information extracted from the interference fringe patterns to determine the total number of electrons present. Plasma luminosity viewed axially through a Kerr cell shutter is deduced to be highly representative of electron distributions. He–Ne laser coupled resonator data agree to within ±30% to the interferometer data. Numerical predictions of a modified Hain–Roberts digital computer code agree with the experimentally deduced trends. (USGRDR) (auth)

23079 (AD-675210) MEASUREMENT OF EXCITATION AND ELECTRON TEMPERATURE IN A NITROGEN PLASMA. Final Report, June 1967–June 1968. Bertrand, W. T.; Mason, A. A.; McGregor, W. K. Jr. (Arnold Engineering Development Center, Arnold Air Force Station, Tenn. ARO, Inc., Arnold Air Force Station, Tenn. Tennessee Univ., Tullahoma. Space Inst.). Sept. 1968. Contract F40600-69-C-0001. 48p. (AEDC-TR-68-187). CFSTI.

The objective of the work was to measure the atomic line radiation of nitrogen in the spectral range from 7000 to 12,000 A and to examine the population distribution of excited states to determine if a Boltzmann distribution existed and, consequently, whether an excitation temperature could be defined. Simultaneous measurements using Langmuir probes were made to determine electron temperatures. These measurements were applied to a low-density plasma produced in an arc-jet and expanded into a low-pressure chamber. A one-meter Czerny–Turner scanning spectrometer was used to record the atomic line spectra. Results indicate a difference in the spectroscopic temperature measurements and Langmuir probe measurements of approximately 2000°K. Reasons for this difference are discussed. (auth) (USGRDR)

23080 (IPP-1/88) A He-Ne LASER INTERFEROMETER FOR THE APPLICATION TO PLASMA DIAGNOSTICS. Freund, J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1968. 43p. (In German). Dep.

The physical and experimental principles of a modified Ashby–Jephcott IR laser interferometer for electron area density measurements of either long or toroidal plasma discharges are described. In this interferometer the IR beam is reflected back onto itself by an external mirror oscillating at low frequency, and is detected by a fast, sensitive semiconductor detector. The mirror oscillator has been constructed so that it is stable against misalignment, and is used only during the linear part of its sinusoidal oscillation. Modulation frequencies up to 2 Mc are obtainable. In the case of plasma between the driven mirror and the laser resonator there is an additional modulation superimposed upon the periodic modulation caused by the mirror that corresponds to the electron area density changes of the plasma. It is possible to evaluate area densities as low as 10^{15} electrons/cm^2 with a time resolution of 0.5 μsec. The area density measured across the diameter in the middle plane of a z-pinch discharge has been compared with the results of Mach–Zehnder interferograms taken along the z axis. (auth)

23081 (IPP-1/90) DETERMINATION OF THE ION ENERGY OF A DEUTERIUM PLASMA FROM THE ABSOLUTE NEUTRON YIELD IN A THETA-PINCH. Sommer, J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1968. 49p. (In German). Dep.

The principles of determining the ion energy of a deuterium plasma from the absolute neutron yield in a theta pinch are discussed. The error is given in the ion energy for various velocity distributions of the deuterons. The absolute determination of the total neutron number and the neutron rate is discussed. In particular, a detailed description is given on the silver counter calibration by the neutron generator, allowance being made for the scattering of the neutrons in the Isar I theta pinch device. (auth)

23082 (IPP-3/80) MEASUREMENTS OF THE DENSITY AND THE TEMPERATURE OF AN ARGON PLASMA JET BY MEANS OF A MACH-ZEHNDER INTERFEROMETER. Witkowski, S. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1968. 14p. (In German). Dep.

The interferometric measurements and the evaluation of the local densities and temperatures in the outer regions of a plasma jet are described. Density and temperature profiles are given for a plasma jet with an argon mass flow of 0.14 m^3/h generated in an arc burner with a nozzle diameter of 7 mm and an arc current of 200 A. (auth)

23083 (LRP-38/68) MEASUREMENT OF THE ELECTRON DENSITY GRADIENT BY THE SCHLIEREN METHOD IN A PLASMA CONFINED BY A ROTATING HF FIELD. Peiry, J.-M. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Dec. 1968. 40p. (In French). Dep.

A Schlieren system is described and streak pictures are presented which show the development with time of the electron density gradient in a rf rotating magnetic field pinch. Photographic densitometry of one of the streak photographs shows that it is possible to obtain quantitative measurements of the electron density gradient and, by means of numerical integration, the form of the density profiles. Absolute values of the density are evaluated. The precision and limitations of the method are analyzed and some improvements are proposed. (auth)

23084 (N-68-20940) THE SCATTERING OF CHARGED PARTICLES IN A WEAKLY UNSTABLE PLASMA. Roque, Celso (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Mar. 1968. 25p. (NASA-CR-93970). CFSTI.

The mean-square deflection of suprathermal test particles from a weakly unstable electron plasma is calculated. The instability is assumed to have been driven by a tenuous beam of energetic electrons. The random phase approximation expression for the spectral density is used and the electric field energy density of the turbulent spectrum is estimated by the quasi-linear theory. It is shown that the mean-square scattering angle can be increased by more than an order of magnitude by a suitable beam density or drift velocity. This enhances the potential usefulness of charged particle scattering as a diagnostic tool for turbulent laboratory plasmas. (auth) (STAR)

23085 (UCRL-71572) PRESENT AND FUTURE 2X DATA SYSTEMS. Vogtlin, George E. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 24, 1969. 9p. (CONF-690407-14). Dep. CFSTI.

From Symposium on Engineering Problems of Fusion Research, Los Alamos, N. Mex.

The data systems on the 2X Machine are rapidly changing to meet the requirements of increased plasma life and density. In particular, the study of multiple ion species, including the effects of carbon impurities, has greatly increased the number of channels and the complexity of measuring the ion cyclotron frequencies. The present data system on the 2X Machine uses oscilloscopes and Polaroid film cameras. A key diagnostic system is the raster oscilloscope, which permits the measurement of frequencies to 100 MHz and has recently been delayed between sweeps to permit sampling at intervals of 10 μsec. An important feature of these measurements is the use of band-pass filters. A computer program was written to speed the design of M-derived filters. The use of computers is now limited because of the time required to digitize and process the data. In addition, the recent extension of plasma life has made the time resolution of the present oscilloscope inadequate. A new data system is being purchased that has a 40-channel analog disc recorder and a digital computer. This unit should be able to record 30 msec of data with a 500-kHz frequency response and a high signal-to-noise ratio. The information can then be digitized by a single analog-to-digital converter and processed on a computer. The rotational speed of the disc permits the computer to sample data recorded on a channel at 30 times per second. The data will be processed for immediate use and stored in digital form. (auth)

23086 EDGE EFFECT OF A FLUSH ELECTROSTATIC PROBE. Schubert, Gerald (Univ. of California, Los Angeles). Phys. Fluids, 12: 576-85(Mar. 1969).

The edge effect problem for a flush electrostatic probe is modeled by the flow of a weakly ionized compressible gas past a discontinuous wall potential. The basic flow is a Couette flow and the potential jump is applied at the lower wall which is thus divided into positive and negative current collectors. For a sufficiently small applied potential discontinuity the problem may be linearized about a basic state whose characteristics are known numerically. The linear problem retains the full coupling and ellipticity of the nonlinear one. Results are presented for the total current collected by each electrode, the magnitude of the jump in current density at the junction of the electrodes and the dependence of this quantity on Reynolds number, the first-order moments of the current density, and the upstream and downstream length scales for the current collection. For conditions investigated here, these length scales are several channel thicknesses. Thus, the operation of a flush electrostatic probe may be completely dominated by edge effects. (auth)

23087 PLASMA SCANNER AND DATA PROCESSING SYSTEM FOR CURRENT–VOLTAGE CURVES. Gritzmacher, Thomas J.; Boyer, Ellsworth L.; Holt, James F. (Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio). Rev. Sci. Instrum., 40: 721-31(May 1969).

A new plasma diagnostic tool, called a plasma scanner, has been developed for use in obtaining current cross sections and current-voltage characteristics of a hollow cathode magnetically confined arc plasma in argon. The scanner assembly consists of an annular copper arc anode, a boron nitride baffle, a boron nitride scanning wheel, and a plane copper current collector. To obtain current cross sections the wheel was rotated at 1 rpm. To obtain current-voltage characteristics, the wheel was stopped with the collector exposed to the plasma through a chosen scanner hole. Most of the data were produced in an arc of 20 A and 45 V. A cylindrical Langmuir probe provided data for comparison. The scanner showed a sharp increase in electron current in the center of the arc, whereas the probe did not. Typical temperatures derived from the scanner were 4 eV while temperatures obtained using the probe were 3.2 eV. Electronic equipment gave a direct readout of the inverse of the electron temperature. (auth)

23088 METHODS OF PLASMA DIAGNOSTICS. PART I. Somesan, Maria (Inst. of Physics, Bucharest). Stud. Cercet. Fiz., 20: 705-45(1968). (In Rumanian).

The methods employed to determine the fundamental parameters of a plasma, such as charge density and temperature, are collectively known as "plasma diagnostics." They include spectroscopic measurements, based on the study of the intensity of the emitted line or continuous spectrum and determination of the line width. The methods are identical with those used in electronics or interferometric measurements. At low temperatures and short wavelengths, the bremsstrahlung data may be used for temperature measurements. For continuous-field spectroscopy, the spectral region selected for the measurement should not contain lines generated by discrete transitions. Several methods are based on the study of the broadening of the spectral lines. The interferometric methods, are related to the absorption of the plasma in the medium. The "schlieren" shadowgraph technique is also mentioned. (TTT)

23089 STUDY BY PHOTOELECTRIC SPECTROSCOPY IN THE VISIBLE RANGE OF THE RADIAL DISTRIBUTION OF TEMPERATURES OF AN ARGON AND A HYDROGEN PLASMA. Queffelec, Jean-Louis (Faculte des Sciences, Rennes, France). Compt. Rend., Ser. A, B, 268: 386-9(Feb. 3, 1969). (In French).

The radial distribution of temperatures of an arc plasma, stabilized by atmospheric pressure, was measured by photoelectric spectroscopy in the visible region using the method of Stark broadening of the H_β line of hydrogen. (J.F.P.)

23090 EFFECT OF PLASMA INHOMOGENEITY ON ATOM TEMPERATURE MEASUREMENTS IN A GAS DISCHARGE. Pavlovskaya, E. N.; Podmoshenskii, I. V. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 273-5(Oct. 1968).

Translated from Opt. Spektrosk., 25: 488-92(Oct. 1968).

A comparison of the kinetic temperature T_p of gas atoms and the population distribution temperature T_p of adjacent levels with $\Delta E < 0.1$ eV, is made for a homogeneous and an inhomogeneous source of high-frequency discharge in neon. It is shown that the temperature T_a of the hot portions of an inhomogeneous source can be measured by T_p. (auth)

23091 NUMBER DENSITY FLUCTUATIONS IN AN EQUILIBRIUM ELECTRON PLASMA. Saleeby, Buddy Badri. Evanston, Ill., Northwestern Univ., 1968. 68p.

Thesis.

A pair of coupled equations governing the evolution of the fluctuations in number density in phase space for an equilibrium electron plasma and valid to second order in the plasma parameter, $\epsilon = {}^1\!/_n\, \lambda^3$ (so as to include the collisions), is derived in two ways using (a) the Liouville equation applied to a two-time distribution function in Γ space, and (b) the Klimontovitch equation which governs the evolution of the exact (classical) number density in phase space. The derived equations, which are formally identical to the linearized equations for F and g (obtained from the BBGKY heirarchy), are then treated using a "shielding" approximation which is a generalization for short times and spatial inhomogeneity of the method leading to the Landau form of the Fokker–Planck equation; the spectral density for the electron number density fluctuations in ordinary space is obtained and collisional corrections to the resonance phenomenon at $\omega \approx \omega_p$ for $k/k_0 \ll 1$ given. (Diss. Abstr.)

23092 ELECTRON HEAT TRANSFER IN A WEAKLY IONIZED PLASMA. McAssey, Edward Vincent Jr. Philadelphia, Univ. of Pennsylvania, 1968. 154p.

Thesis.

The problem of determining the electron heat transfer to a spherical body and the characteristics of a probe immersed in a weakly ionized plasma is examined. Asymptotic solutions including ionization and recombination have been developed for a quiescent plasma and for the stagnation region of a flowing plasma. The range of validity of the analysis depends upon the ratio of R_D/l_+ and R_{ec}/R_e (R_D, l_+, R_{ec}, and R_e are the Debye length, diffusion length, Reynolds number for chemistry, and Reynolds number). Based on the relative magnitudes of these parameters, the analysis shows the existence of a collision dominated sheath near the body surface, a quasi-neutral region, and an inviscid region. By considering the problem in terms of nondimensional parameters, it is possible to examine a wide range of physical situations. Sample curves for the electron flux, net current, and body potential are included. The results show that the electron heat transfer is strongly dependent upon body potential. A method is proposed for using these results for diagnostic purposes. (Disser. Abstr.)

23093 CHARGE CARRIER CONCENTRATION DETERMINATION BY MEANS OF A DOUBLE PROBE IN PLASMA WITH DRUYVESTEYN-DISTRIBUTION OF ELECTRON COMPONENTS. Wilhelm, J.; Winkler, R. (Institut fuer Gasentladungsphysik, Griefswald, Ger.). Beitr. Plasmaphys., 8: 275-81(1968). (In German).

Beginning with the difficulties discussed on the basis of an individual example in the evaluation of single-probe characteristic lines in the presence of Druyvesteyn distribution, a study was made on the determination of the concentration of charge carriers using double probes. The layer expansion of a probe in the floating potential was given in tabular form as a function of characteristic parameters. These tables permit a concentration determination in practical cases. (tr-auth)

23094 DETERMINATION OF THE ELECTRON DENSITY IN THE MEDIAN PLANE OF A NEON PLASMA BY USING FORMULAS FOR TRANSMISSION AND REFLECTION COEFFICIENTS IN THE APPROXIMATION OF A TRAPEZOIDAL DISTRIBUTION. Marzat, Claude (Laboratoire d'Optique Ultra-Hertzienne, Bordeaux. CNRS, Talence, France). Compt. Rend., Ser. A, B, 268: 253-6(Jan. 20, 1969). (In French).

Formulas proposed previously are used for calculating transmission and reflection coefficients of a plasma in the hypothesis of trapezoidal distribution of electron density. It is shown how one can choose the form of the trapezoid. At the same time, results obtained for a neon plasma are given as a function of current, confining field, and pressure. (tr-auth)

23095 STUDY OF THE LUMINOUS RADIATION EMITTED DURING AN AZIMUTHAL PINCH IN ARGON. Etaix, Jean-Francois (Laboratoire d'Electronique et de Physique Appliquee, Limeil, France). Compt. Rend., Ser. A, B, 268: 230-3 (Jan. 20, 1969). (In French).

A dense argon plasma is produced by an azimuthal low-energy discharge. The plasma diagnostics are carried out at the instant of maximum compression. The emitted light spectrum is determined and the quantity of radiated energy is measured. This passes through a maximum as a function of the pressure. (tr-auth)

23096 SIMPLE DETERMINATION OF ELECTRON DENSITIES IN PLASMAS SUBMITTED TO MAGNETIC FIELDS. Belland, P.; Drawin, H.-W.; Tittel, H. O. (EURATOM-CEA, Fontenay-aux-Roses, France). Z. Phys., 222: 372-9(1969).

A method is described to measure electron densities in plasmas with a sufficiently strong magnetic field superposed. The profiles of the spectral lines emitted by such a plasma are shaped by the Stark and Zeeman effect (Lorentz-triplet). Eliminating the central Zeeman component by a polarizer or observing in field direction, one gets a doublet, in which for a given spectral line and magnetic field strength the ratio I_0/I_z of minimum to maximum intensities is only a function of the electron density. Measuring this ratio one finds the corresponding densities by means of calibration curves given below for the He I line $\lambda = 5876$ Å. This calibration is independent of the spectral arrangement, when utilizing a polarizer for the spectral observation. (auth)

23097 OBSERVATION OF FAST NEUTRALS PROJECTED FROM A COAXIAL GUN. Gloersen, Per (General Electric Co., King of Prussia, Pa.). Phys. Fluids, 12: 945-7(Apr. 1969).

Xenon atom and ion densities were measured downstream from a coaxial plasma gun using vacuum ultraviolet emission, absorption spectroscopy, and a Langmuir probe. A pulse of fast neutrals was observed to emerge, in addition to a faster pulse of ions. (auth)

23098 AXIAL CURRENT DENSITY MEASUREMENTS IN A WIDE UNSTABLE PLASMA COLUMN. Ventrice, Carl A.; Smith, Nicholas K. (Auburn Univ., Ala.). Phys. Fluids, 12: 883-6(Apr. 1969).

Axial current density measurements are made in an argon plasma column by means of a multiring composite anode. The existence of an instability in a column which has an L/R of six is confirmed. The critical magnetic field B_c is determined and found to depend on the neutral gas pressure p_g in proportion to $p_g^{0.45}$. In all cases, when $B \geq 1.36B_c$, a reversion is observed to begin, back to a configuration similar to that which exists when $B < B_c$. When $B < B_c$, the axial current density on the tube axis is observed to increase with increasing B, indicating that a "modified Schottky" theory must apply. (auth)

23099 ELECTRON DENSITY MEASUREMENT BY MEANS OF AN IMPROVED INTERFEROMETER. Heym, A. (Laboratoire de Recherches sur la Physique des Plasmas, Lausanne, Switzerland). Plasma Phys., 10: 1069-75(Dec. 1968). (In French).

A Mach–Zehnder interferometer is described which is used for electron line density measurements of a rapidly varying plasma. Fringe detection is made with a system of two photomultipliers which allows following the sense of variation of the electron line density in an unambiguous manner. The sensitivity of the device (approximately 0.01 fringe) allows precise measurements to be made in experimental situations where electron line density variations produce only fractions of a fringe shift. This interferometer was used to measure the electron line density of an axial current discharge in 25-mtorr H^2. The density profile of the plasma is obtained by scanning a 3-mm-wide He–Ne laser beam across the diameter of the discharge tube. Complete ionisation of the gas is found after 9 μsec. (auth) (UK)

23100 OPTICAL MEASUREMENTS ON LASER-PRODUCED PLASMAS. Faugeras, P. E.; Mattioli, M.; Papoular, R. (EURATOM CEA, Fontenay-aux-Roses, France). Plasma Phys., 10: 939-49(Oct. 1968).

Measurements are described of the light emitted and transmitted by the plasma resulting from the interaction of a Nd glass laser beam with a small pellet of lithium hydride suspended in vacuum. The effects obtained by varying the laser energy are particularly considered. A comparison of these results with the predictions of the current theory shows some disagreement, the possible origins of which are discussed. (auth) (UK)

Kinetics (General)

23101 IMPEDANCE AND EQUIVALENT CIRCUIT DIAGRAM OF THE LOW-PRESSURE POSITIVE COLUMN AT SMALL DISCHARGE CURRENT STRENGTHS. Deutsch, H. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Beitr. Plasmaphys., 8: 329-39(1968). (In German).

On the principle of a linear theory, an equivalent circuit was derived for the impedance of the column plasma in the low-current low-pressure glow discharge. It was shown how the elements of this circuit are transformed in the transition to the usual discharge column. The theory yields complex time constants of the equivalent current circuit for discharge conditions which lead in the positive column to self-regulation of ionization waves (p type). (tr-auth)

23102 DOUBLE VORTEX FLOWS IN PLASMAS AXIALLY TRAVERSING MULTIPOLE MAGNETIC FIELDS. Barney, Gerald O.; Sprott, J. C. (Univ. of Wisconsin, Madison). Phys. Fluids, 12: 707-12(Mar. 1969).

Detailed observations of 100-eV hydrogen plasmas moving in a linear quadrupole and a toroidal octupole magnetic field show that the plasmas polarize and that the field lines quickly become equipotentials. The plasmas E × B drift with negligible diamagnetism in double vortex flow patterns similar to the self-consistent solutions of Poukey. The agreement is not perfect presumably because the uniform field and steady state assumed in the theory are lacking in the experiments. (auth)

23103 INDIRECT DETERMINATION OF THE RADIATION COMPONENT IN THE ENERGY BALANCE OF WALL-STABILIZED Hg AND Xe HIGH-PRESSURE ARCS. Neumann, W.; Worm, M. (Physical-Technical Inst., Berlin). Beitr. Plasmaphys., 8: 341-7(1968). (In German).

The total radiation power of wall-stabilized Hg and Xe high-pressure arcs per unit length was determined as a function of the electrical power per unit length over the power balance in the arc boundary zone. The knowledge of the radial temperature distribution in this zone is essential. It is shown that the radiation thus determined is higher in the case of Hg by 7%, and in the case of Xe by 14%, than the directly measured radiation, in which a part of the emission occurring outside the visible range was filtered between arc and thermoelement by quartz glass or (in the case of xenon high-pressure arcs) also by water and glass. (tr-auth)

23104 NONEQUILIBRIUM CALCULATIONS ON LAVAL-NOZZLE PRODUCTION OF PARALLEL-BEAM PLASMA. Artmann, J. (Institut fuer Plasmadynamik, Stuttgart). Z. Naturforsch., 23a: 2132-4(Dec. 1968). (In German).

On the basis of the simplest possible model representation some theoretical studies of flowing plasmas were made and compared with experimental results. The plasma considered is a force-free plasma parallel beam which was produced by means of a plasma burner by flash evaporation of an arc-heated argon plasma in a Laval nozzle. The results showed that as the electron density increased, the electron temperature decreased more or less rapidly, but the electron density and gas temperature remain constant in the framework of the order of accuracy. The relaxation time for the recombination is much greater than the transmission time of the plasma whereas the relaxation time of the temperature equilibrium by elastic collision lies completely in the order of magnitude of the transmission time. The relative fast flow delays the ionization in the low-temperature range. An ionization equilibrium is not attained. (J.S.R.)

23105 RF DEFOCUSING OF A SELF-FOCUSED BEAM IN A BEAM-GENERATED PLASMA. Stallard, Barry Winston. Stanford, Calif., Stanford Univ., 1968. 92p.
Thesis.

A beam injected into a region containing a low-pressure neutral gas (10^{-4} to 10^{-2} torr) creates a plasma by beam–neutral ionizing collisions. For radial plasma drainage, the equilibrium potential in the plasma decreases monotonically with radius and is a confining well for electrons, thus pinching the beam and confining it to the tube axis for some distance in the plasma. This process is known as ion focusing, or the electrostatic pinch effect. A second focusing process exists for partially or fully neutralized beams. This is the magnetic pinch effect and is the result of the self-magnetic field of the beam. At high beam voltage or perveance the magnetic forces exceed the electrostatic. Consequently, two regimes exist in which either the electrostatic or the magnetic pinch is the dominant beam focusing mechanism. Existing simultaneously with beam pinching are a number of processes which act to defocus or scatter beam electrons. For many common laboratory beams the most important is beam scattering as a result of radial rf electric fields accompanying the convective growth of noise fluctuations due to beam–plasma interactions. The purpose of this thesis is to compare theoretical and experimental results for beam defocusing due to this cause. Theoretical considerations show that for thin beams the transverse mode (m = 1) is the important mode for defocusing. A simple theory for defocusing by radial fields of this mode is presented for two cases: (1) noise fluctuations which exhibit no growth along the beam and (2) fluctuations which grow exponentially. Both cases predict defocusing. Defocusing for Case (1) is due to a resonance between the nearly uniform radial fluctuating fields and the oscillations of the beam electrons in the parabolic potential well of the self-focusing fields. For Case (2), defocusing is due to high-amplitude radial fields. The experiments performed verify the importance of the growing transverse mode in defocusing electrostatically pinched beams. Good agreement is obtained between experiment and the defocusing length predicted by theory for Case (2). Several other significant results are observed. There are measured increases along the beam of plasma electron temperature. On this basis, equilibrium theory predicts a shortening of the length for beam pinching and a decrease in plasma density. Experimental observations of these two effects are in agreement with the theory. Also observed is a variation in gain along the pinched beam, with a period equal to the distance between adjacent minima in the beam radius. This effect is predicted by theory and results from a variation in beam density due to pinching. (Disser. Abstr.)

Kinetics (Experimental)

23106 (AE-350) FORMATION OF NEGATIVE METAL IONS IN A FIELD-FREE PLASMA. Larsson, Egon (Aktiebolaget Atomenergi, Studsvik (Sweden)). Feb. 1969. 31p. Dep.

A field-free and homogeneous plasma of large volume is formed by neutron irradiation of ^{3}He at a density corresponding to NTP and at gas temperatures in the range 300 to 1600°K. The accuracy and ease by which the source density of free electrons can be varied and controlled offers special possibilities to study recombination and attachment phenomena in the absence of diffusion. These possibilities are described and utilized for the study of the effects of mixing the helium gas with metal vapors. Attachment of electrons to neutral metal atoms is found to be the dominant cause of electron removal for metal concentrations above certain limits. Negative metal ions are formed and the rate of their formation was determined to be about 10^{13}/cm^3/sec. Evidence is also presented, that for such conditions where formation of negative metal ions does not occur, the electrons are lost in electron–ion recombinations, in which the third body is not an electron. No molecular helium spectrum is observed from the plasma when it is very close to spectroscopic purity. Instead, between 3000 to 7000 Å only one atomic helium line at 5875 Å is observed. The recombination of He_2^+ may therefore be dissociative. A difference in recombination behavior between ^{3}He and ^{4}He at high pressures may therefore exist considering results from previous work on ^{4}He. (SWED)

23107 (IPP-2/65) ANOMALOUS DIFFUSION AND OSCILLATIONS IN AN AFTERGLOW PLASMA. Dodo, T. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov. 1967. 31p. Dep.

Diffusion and oscillations of helium and neon plasmas in a glass chamber were examined. The method of the experiment is the same as in the experiment in a metal chamber. The diffusion coefficient and the behavior of the oscillations in the plasma is quite the same as in the case of metal chamber. When $\omega_{ci}\tau_{in} < 1$, there are no oscillations in the plasma density, and the diffusion is classical. When $\omega\tau > 1$, oscillations appear in the plasma density and the diffusion becomes anomalous and 0.3 times Bohm diffusion. The shape of the fluctuation of the plasma potential is the same over the plasma volume and the fluctuating electric field is very small (<0.2 mV/cm), when $\omega\tau < 1$. When $\omega\tau > 1$, the fluctuation of the plasma potential becomes turbulent and the amplitude of fluctuating electric field becomes large (≳3 mV/cm). (auth)

23108 (RISO-186) SHOCK FORMATION IN A Q-DEVICE PLASMA. Michelsen, Poul (Danish Atomic Energy Commission, Risoe. Research Establishment). Dec. 1968. 38p. Dep.

Experiments on shock formation and shock reflection in a Q device are described. In connection with these a numerical integration of the appropriate fluid equations is executed. The result of the experiments is that shock formation is possible when the ion temperature is decreased by ion-neutral collisions and the density is not too low. The shock reflection experiment indicates that $\gamma_{ion} = c_p/c_v = 5/3$. The numerically analyzed fluid equations include the viscosity and heat-conduction terms, and also momentum and energy transfers between different kinds of particles are taken into account. Some stability and error-indication problems connected with the equations are considered. (auth)(Denmark)

23109 (RISO-188) DIFFERENTIAL ION COOLING IN A Q-DEVICE. Andersen, S. A. (Danish Atomic Energy Commission, Risoe. Research Establishment). Feb. 1969. 11p. Dep.

A new method of ion cooling in a Q-device is described. Experiments show that a temperature ratio $T_e/T_i \sim 3$ is attainable, and that a high degree of ionization is maintained in the plasma column except for the small region where a dense neutral cloud is localized to perform the ion cooling through ion-atom collisions. (auth) (Denmark)

23110 PARAMETRIC INSTABILITY AT INTERACTION OF MODULATED BEAM WITH PLASMA IN A MAGNETIC FIELD. Pyatak, A. I.; Shevchenko, V. I. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 197-201(1969). (In Russian).

The interaction of a density-modulated beam of charged particles with plasma in a magnetic field under the parametric resonance conditions is investigated. The widths of zones of parametric instabilities and their increments were found when exciting longitudinal plasma oscillations. (auth)

23111 INVESTIGATION OF SOME ELECTRIC CHARACTERISTICS OF PLASMA IN A HF FIELD. Tam Pin Than; Andreev, A. D. (Belorussian State Univ., Minsk). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 194-6(1969). (In Russian).

Experimental studies were made of plasma perturbations of the positive column of a glow discharge in air by a high-frequency field. The dependence of the plasma potential near the wall on the frequency at different gas pressures and different distances from the channel wall was studied. The value of the specific plasma conductivity was determined along the linear section by volt-ampere characteristics of the double probe. This value of the conductivity was compared with the value determined for the same experimental conditions by the resonance curve. (auth)

23112 NONLINEAR EFFECTS AND TURBULENT BEHAVIOR IN A BEAM-PLASMA INSTABILITY. Apel, J. R. (Johns Hopkins Univ., Silver Spring, Md.). Phys. Fluids, 12: 640-8(Mar. 1969).

Continuing experimental studies of beam-plasma interactions in a magnetic field have shown an assortment of nonlinear effects to be present during a well-developed instability. Observations have been made of: the vanishing of the spatial growth rate; electron cross-field diffusion in synchronism with the unstable electric field; generation of harmonics of the fundamental interaction frequency up to the seventh; similarities in the spatial behavior of all seven harmonics; and the existence of a wavenumber power spectrum whose average behavior over the domain of the harmonic peaks is proportional to $k^{-5\pm0.5}$, in agreement with certain theories of plasma turbulence. The data suggest that the large-amplitude fundamental electric field is the driving force for the nonlinearity that generates the harmonics, and that the fundamental, and the harmonics as well, represent waves traveling with a phase velocity equal to that of the slow space-charge wave on the electron beam. An interpretation is offered in terms of an approach to stationary plasma turbulence through a linear beam-plasma interaction, followed by harmonic generation, wave-wave coupling, and ultimate broadening of the emission peaks into a continuous spectrum. (auth)

23113 ANOMALOUS SKIN EFFECT IN BOUNDED PLASMAS. Reynolds, J. A.; Blevin, H. A.; Thonemann, P. C. (United Kingdom Atomic Energy Authority Research Group, Abingdon, Eng.). Phys. Rev. Lett., 22: 762-4(Apr. 14, 1969).

The penetration of an electromagnetic field into a cylindrical plasma has been measured under conditions where the electron mean free path is comparable with the plasma diameter. The experimental results are in qualitative agreement with a theoretical model in which electron thermal motion is included. (auth)

23114 EXPERIMENTAL INVESTIGATIONS ON MOVING LAYERS. Gundermann, S. (Institut fuer Gasentladungsphysik, Greifswald, Ger.). Beitr. Plasmaphys., 8: 263-74(1968). (In German).

In the transition region between homogeneous and layered columns, the field strength, electron temperature, and ion concentration fluctuations were determined in the axial direction. The measurements were made exclusively on the externally excited p layers in neon. In the investigations, the pressure was between 0.8 and 2.3 torr, the current between 2 and 25 mA. The experimentally obtained curves show that the fluctuations decrease significantly perpendicular to the wall in comparison with the previous simple representations. The decrease is independent of the frequency and also of the amplitude for not-too-great fluctuations. The greatest decrease in the radial direction is shown by the field intensity fluctuation and the electron temperature fluctuation is the smallest. The difference was probably caused by the large heat conductivity of the electron gas. The experiment also produced the fact that the layers are not propagated in the form of plane waves but possess a curved wave front. The curvature increases with the frequency. (tr-auth)

23115 CRITICAL MAGNETIC FIELD FOR DISAPPEARANCE OF THE MOVING STRIATION. Sato, M. (Yamagata Univ., Yonezawa, Japan). Phys. Lett., 28A: 555-6(Jan. 27, 1969).

There is a critical magnetic field above which the moving striation in a longitudinal magnetic field disappears abruptly. This critical field depends on the discharge current. (auth)

23116 INVESTIGATION OF THE POSITIVE COLUMN OF NEON DISCHARGES AT AVERAGE GAS PRESSURES. PART II. Golubovskii, Yu. B.; Kagan, Yu. M.; Lyagushchenko, R. I.; Michel, P. (Leningrad State Univ.). Beitr. Plasmaphys., 8: 445-53 (1968). (In German).

The electric longitudinal field intensity, the electron temperature and electron concentration in the discharge axis, the radial distribution of the electron concentration, and intensity of the radiation in neon were measured at various currents and pressures. The experimental results are compared with theory. (tr-auth)

23117 TRANSPORT AND BALANCE COEFFICIENTS IN WEAKLY IONIZED NEON AND HELIUM PLASMA IN HOMOGENEOUS ELECTRIC FIELDS. Wilhelm, J.; Winkler, R. (Institut fuer Gasentladungsphysik, Greifswald, Ger.). Beitr. Plasmaphys., 8: 405-22(1968). (In German).

The quantitative treatment of phenomena of weakly ionized homogeneous and inhomogeneous low-pressure-column plasmas in rare gases necessitates especially the accurate knowledge of transport and balance coefficients of the electrons in their dependence on the axial column gradients. Calculations of the electron-single particle velocity distribution function have produced recently the detection of a strong influence of the inelastic collisions of the electrons with the neutral gas on the form of the distribution function; corresponding variations of the numerical values of the transport and balance coefficients are connected with this. It is the purpose of this study to calculate the mobility, diffusion coefficients, the mean energy, and the collision frequency of the directionalization of the electron component in an E/p_0 region of interest for column plasma in the rare gases Ne and He under the inclusion of elastic and inelastic collisions. These calculated values are partially compared with known experimental values. (tr-auth)

23118 INTERACTION OF A PLASMA WITH A TRANSVERSE MAGNETIC FIELD. Parkin, Curtis Willard. Nashville, Vanderbilt Univ., 1968. 91p.

Thesis.

In this experiment induction, transport, and decay of a plasma field, due to a transverse applied dc magnetic field-plasma flow interaction, are observed. The applied field (B_a) is sharply localized. The experiment is conducted using peak bank currents (I_p) of 65 to 160 kA and initial pressures (P_0) of 50 to 1000 μ in argon. Search coils detect induced plasma magnetic fields (B_p) as large as 590 G. Small transported fields are detected as far as 17 cm downstream from the applied field midpoint, well outside the applied field region. The plasma is found to behave qualitatively as an RL circuit as it passes through the applied field. The induced plasma field is initially directed antiparallel to the applied field; it peaks, declines, then crosses over to parallel polarity somewhere downstream from maximum applied field as the plasma moves through. When the plasma leaves the applied field region, the field remaining in the flow decays exponentially. Measured B_p profiles allow calculation of decay times (τ) and magnetic Reynolds numbers (R_m) which agree well with an MHD theory involving assumption of conductivity reduction in the applied field region and blast wave profiles of flow parameters. Calculated decay times, which range from 0.6 to 1.15 μsec downstream from the applied field region, show a reduction to as low as 0.1 μsec in the high-field region, in agreement with theory. Magnetic Reynolds number correspondingly varies from a range of 1.0 to 5.0 (where $B_a = 0$) to 0.2 (in the high-B_a domain). The size of the characteristic plasma length which gives best data-theory fit ($L_0 = 0.8$ cm) indicates induced field diffusion primarily in the shorter, transverse directions rather than in the flow direction. Analysis in the pure decay region for a range of bank and pressure conditions shows a linear relationship of R_m with flow velocity (i.e., with $I_pP_0^{-½}$). Decay times, however, show little variation with flow velocity. This finding emphasizes that the luminous plasma front found in this experiment is not a true shock front since its temperature shows little change with velocity. Nor do image converter photographs indicate a true shock front; rather, they show a turbulent, unstable plasma. (Disser. Abstr.)

23119 THE ABSORPTION OF A XENON PLASMA IN THE CONTINUUM REGION. Andreev, S. I.; Baikov, O. G. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 269-70(Oct. 1968).
Translated from Opt. Spektrosk., 25: 481-3(Oct. 1968).

This study is devoted to an experimental determination of the absorption coefficients in the continuum of a xenon plasma in an induced (electrodeless) discharge, where there are none of the electrode decomposition products usually present in tubular electrode lamps. The absorption coefficients were obtained by illuminating the plasma with an external source. The accuracy of the absorption-coefficient calculations carried out by other authors is discussed. (auth)

23120 AXIAL STRIOGRAMS OF FOCUSED NONCYLINDRICAL DISCHARGE. Baconnet, Jean-Pierre; Cesari, Georges; Coudeville, Alain; Watteau, Jean-Paul (CEA, Limeil, France). Compt. Rend., Ser. A, B, 268: 226-9(Jan. 20, 1969). (In French).

A qualitative study of the structure of a plasma focused in front of the interior electrode of a coaxial gun is made with the help of striograms. The plasma is flashed near the axis by a discharged laser, and the exposure time for the axial striograms is 1 nsec. (tr-auth)

23121 TEMPERATURE DECAY AND RECOMBINATION IN HELIUM AFTERGLOW PLASMAS. Born, Gunhard K.; Buser, Rudolf G. (Army Electronics Command, Fort Monmouth, N. J.). Phys. Rev., 181: 423-9(May 5, 1969).

The effect of the temperature of the neutral gas on the decay of electron temperature and density in helium afterglow plasmas ($p = 0.3$ to 0.7 torr, $N_e \approx 10^{13}$ cm^{-3}, $T_e \approx 2000$°K) is investigated. Density and temperature of the electrons and the concentration of metastable atoms are measured with optical and microwave methods; the gas temperature is determined from standing acoustic waves excited by the discharge. In the range investigated no difference is found during the afterglow between the temperatures of the electrons and of the gas which is heated in the discharge. The slow electron-temperature decay follows the decay of the elevated gas temperature controlled by heat conduction, and is not affected by electron-heating processes due to metastable atoms and recombination. With collisional–radiative recombination as the major plasma loss mechanism, the plasma decay can be approximately predicted from the initial density and temperature. (auth)

23122 APPLICATION OF MAXIMUM LIKELIHOOD METHODS TO ION SWARM EXPERIMENTS. Barnes, William S. (Univ. of California, Livermore). Phys. Fluids, 12: 810-15(Apr. 1969).

A new device for performing ion swarm experiments is analyzed mathematically, and expressions for ion swarm distributions in this apparatus are derived. Means are presented for estimating the values of ionic drift velocities, diffusion coefficients (both parallel and perpendicular to the electric field), and ion–molecule reaction rate constants by the use of maximum likelihood estimators. Formulas for estimating the statistical fluctuations of the above estimates which are due to the statistical fluctuations of the ion populations are also presented. Methods for judging the appropriateness of the model used for both the experimental geometry and the ion transport process are discussed. For the purpose of illustrating the techniques, these methods are applied to several data samples for the ions H^+ and H_3^+. (auth)

23123 ELECTRICALLY DRIVEN BLAST WAVES. Ferguson, J. L.; Barach, J. P. (Vanderbilt Univ., Nashville). Phys. Fluids, 12: 764-8(Apr. 1969).

Experiments in an electric shock tube operating at a few Torr have shown compression waves moving ahead of the luminous discharge plasma for Mach numbers below 12 to 15. Failure to observe this separation at higher velocities is attributed to mixing caused by a Taylor unstable density distribution and the deceleration of the flow. The unstable distribution is caused by the density rise accompanying ionization behind the shock front. A model based on these assumptions, which correctly predicts separation conditions in argon, is presented. The structure of the shock waves (pressure, flow velocity, and temperature) is approximately described by blast wave theory. The deviations are primarily due to real gas effects. (auth)

23124 THE ELECTRON CYCLOTRON INSTABILITY AND HIGH-FREQUENCY IONIZATION IN A BEAM–PLASMA EXPERIMENT. Hopman, H. J.; Matitti, T.; Kistemaker, J. (FOM-Inst. for Atomic and Molecular Physics, Amsterdam). Plasma Phys., 10: 1051-67(Dec. 1968).

A beam–plasma experiment was achieved using an electron beam (~2 to 3 keV, ~10mA) guided by a magnetic field of 100 to 1200×10^{-4} Wb/m^2, over a pathlength of about 70 cm through He gas (~10^{-4} torr). Plasma densities were determined by means of an 8 cm microwave cavity. By a proper choice of the parameters it is possible to have both the electron cyclotron and plasma instability present. Under these conditions the hf breakdown by the beam-generated waves is caused by the cyclotron instability. The related density fluctuations distort all measurements on the cyclotron instability, such as peak width, peak amplitude, and the dependence on parameters such as chosen magnetic field and gas pressure. Only for a very limited parameter range, with a weak instability, is it possible to compare results with theory. Despite the dc character of the experiment, peak amplitudes could be compared with a linear theory because the instabilities appeared to be pulsed, with pulses rising spontaneously from noise level. Each pulse grows for a fixed time of $\approx 5 \times 10^{-8}$ s, regardless of the magnitude of the plasma density. The pulses appear in groups of about 10, taking together ≈20 μs, and in this time plasma electrons gain energies up to 200 eV. The repetition of such groups of pulses is quite regular, with frequency of ≈10 kHz, depending on n_e. Plasma electrons loose energy by ionizing the neutral gas, and the increase in plasma density during a group of pulses is a quadratic function of the magnetic field and may be as large as a factor of ten. If two or more interaction peaks are present in the time integrated spectra, the pulses of these instabilities alternate in time. (auth) (UK)

23125 WALL POTENTIAL EFFECTS ON A BEAM–PLASMA DISCHARGE. Tamano, Teruo; Maeda, Hikosuke; Sumi, Masahiko; Miyamoto, Goro (Tokyo Univ.). Jap. J. Appl. Phys., 8: 503-4 (Apr. 1968).

In a mirror device with a floating wall, stable characteristics of beam–plasma discharge were observed. The device named "TAPION" has a pulsed electron beam of up to 20 keV and 15 A. When the side-wall was grounded, characteristics of the beam–plasma discharge were similar to those in a previous experiment. About 20 μs after beam turnon, plasma density increased rapidly and exceeded that of neutral gas. Simultaneously, side-wall current increased in a sense of ion current. This increase continued until beam turnoff. After beam turnoff, plasma density decayed with an e-folding time of a few hundred microseconds, depending little on mirror ratios. (M.O.W.)

Kinetics (Theoretical)

23126 (IPP–1) SOME PROPERTIES OF RELATIVISTIC PLASMA RINGS. Kegel, Wilhelm H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec. 1968. 37p. (In German). Dep.

In connection with the project of the electron ring accelerator (ERA), plasma rings are considered which consist of electrons with a relativistic mean velocity and fewer ions with a low mean velocity. The purpose of this report is to derive some necessary conditions for such systems to be in equilibrium. From the relativistic Vlasov equation in cylindrical coordinates, moment equations are derived. From these it follows that the electrons are restricted to a finite volume, if one assumes that all macroscopic quantities of the ring vanish at infinity. Separate radial and axial virial theorems for ions and electrons are derived from the moment equations. They relate the average pressure with the integrals over the spatial moments of the electric and magnetic forces. These relations show that, in general, the ion pressure is anisotropic. Approximate expressions are derived for the virial integrals on the assumption of a low aspect ratio r_0/R. In the case of a homogeneous external field one then obtains relations between the average pressure and the line densities (densities integrated over the cross section) of the electrons and ions. One further obtains an expression, which shows how the major radius R of the ring is increased by the electromagnetic self-interaction of the ring. Finally, it is shown that for the case that the external field is not homogeneous, but a mirror field, the pressure of the electrons in the axial direction is increased appreciably. (auth)

23127 (IPP-1/91) RELAXATION OF HEAVY ION IMPURITIES IN AN ANISOTROPIC DEUTERIUM PLASMA. Lehner, G.; Pohl, F. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov. 1968. 21p. Dep.

The relaxation of the anisotropy of impurity ions in an anisotropic plasma is discussed. The treatment is based on the assumption that all velocity distribution functions are elliptic initially and remain elliptic during the relaxation process. The problem thus reduces to a set of ordinary differential equations for the perpendicular and parallel temperatures of the different kinds of plasma particles. One may hope that such an approximate description of the relaxation is of some help in the interpretation of experimental results. Some examples are treated numerically. (auth)

23128 KINETIC THEORY OF INHOMOGENEOUS SYSTEMS. Price, John C. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Fluids, 12: 593-606(Mar. 1969).

A theory is developed which treats the coupled equations of the various hierarchies as simultaneous equations in time. This scheme proceeds by successive approximations rather than a power series expansion in the small parameter ($[n\lambda_d^3]^{-1}$ in a plasma, nr_0^3 in a Boltzmann gas). The theory is suitable for the derivation of equations for nonuniform and force driven systems. Examples are given for a plasma and a Boltzmann gas. (auth)

23129 BALLISTIC WAKE OF TURBULENCE IN A PLASMA SHOCK WAVE. Krall, Nicholas A.; Tidman, Derek A. (Univ. of Maryland, College Park). Phys. Fluids, 12: 607-13(Mar. 1969).

The role of ballistic terms in the turbulence that occurs in plasma shock waves is discussed. For electrostatic turbulence these terms are shown to give rise to a wake behind a shock wave in which the energy density in the fluctuating fields decays spatially as x^{-3} for a class of distribution functions including resonance functions. The importance of the ballistic transport of turbulent fields inside shocks is also pointed out. This occurs because in such structures there is usually not enough length scale for these fields to phase mix away. Thus, the use of conventional quasilinear theory (which neglects these effects) will often be inadequate to describe even weak turbulence in a shock wave. (auth)

23130 QUANTUM-MECHANICAL INTERPRETATION OF PLASMA TURBULENCE. Ross, David W. (Univ. of Texas, Austin). Phys. Fluids, 12: 613-26(Mar. 1969).

The matrix elements describing nonlinear effects in a weakly unstable plasma are interpreted by means of Feynman diagrams involving the shielded Coulomb potential, given by $V_s(q,\omega) = 4\pi e^2/q^2\epsilon(q,\omega)$, where $\epsilon(q,\omega)$ is the dielectric response function. The quasiparticles or plasmons are obtained for the poles of V_s, but effects of the nonresonant parts of V_s are also retained. All the matrix elements describing interactions of Langmuir oscillations in a strong magnetic field through second order in the quasiparticle numbers are found explicitly and shown to yield the correct classical results in the limit $\hbar \rightarrow 0$. In particular, the equations of Walters and Harris for three-wave scattering in a cold plasma are extended to finite temperatures, and the shielding or dressing of the electrons is included in the equations for the nonlinear Landau damping. The self-energy of a plasmon is also represented by diagrams and the optical theorem is used to compare the self-energy with the scattering matrices. It is found that the quantum method provides a relatively simple way of deriving and interpreting equations for the time development of the wave spectrum and particle diffusion. (auth)

23131 PULSED BREAKDOWN IN NONUNIFORM FIELDS. Epstein, Melvin (Aerospace Corp., El Segundo, Calif.). Phys. Fluids, 12: 728-9(Mar. 1969).

A variational method is described for predicting high-frequency pulsed breakdown of gases having nonuniform properties and/or subjected to spatially nonuniform fields. The method is illustrated by calculating the breakdown criterion for gas contained between two parallel planes. (auth)

23132 ANGULAR AND MOTION VARIABLES FOR A CHARGED PARTICLE IN AN OSCILLATING ELECTROMAGNETIC FIELD. Rebut, Paul-Henri; Samain, Andre (EURATOM-CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser. A, B, 268: 607-10(Feb. 24, 1969). (In French).

The motion of a charged particle in an oscillating electromagnetic field is considered. A method is given for the construction of dynamic variables which allows a simple description of the motion of the particle when the latter is ergodically periodic. (tr-auth)

23133 PROPERTIES OF REVERSIBLE COLLISION OPERATORS. Wisnivesky, D. (City Coll. of New York). Phys. Fluids, 12: 724-6(Mar. 1969).

It is shown that the reversible part of the collision operator determines the form of the radial distribution function. An important limitation of many of the existent kinetic equations is pointed out. (auth)

23134 VARIATIONAL PRINCIPLE FOR STATIONARY MAGNETOHYDRODYNAMIC EQUILIBRIA. Greene, John M.; Karlson, Erik T. (Princeton Univ., N. J.). Phys. Fluids, 12: 561-7(Mar. 1969).

A variational principle of Hamilton's type is constructed for stationary, bounded magnetohydrodynamic flows, also known as stationary equilibria. The chief object is to find how much information must be given in order to have a well-posed problem. The results indicate, but do not rigorously prove, that five suitably chosen functions of a single variable and the location of a rigid conducting boundary defined a unique stationary flow. Comparison is made with other variational principles. (auth)

23135 CORRECTION TO THE KUBO FORMULA. Magan, J. R. (Lehigh Univ., Bethlehem, Pa.). Physica, 35: 193-210 (1967).

A correlation-function formula for electrical conductivity is derived, by a formalism which gives prominence to the total electric field, including fields which may arise from the charged particles which are part of the system being studied. This formula is contrasted to the well-known result of Kubo, which characterizes the response of the system to an external field. The particular formula derived depends on the charges of the particles in such a way that it is significant only for nonsymmetrical electrolytes and plasmas. The importance of the new derivation is that its result differs from the exact and supposedly general Kubo formula, thus calling into question the Kubo formula's applicability to cases where "internal" electric fields might arise. (auth)

23136 DEVELOPMENT OF PARTITION FUNCTION IN BOLTZMANN DISTRIBUTION. VI. FORMULA FOR LN Z. Fulinski, A. (Jagellonian Univ., Krakow). Acta Phys. Pol., 35: 83-90(Jan. 1969).

Summations of the previously obtained infinite series to a closed formula for the partition function Z in the quasi-ideal approximation are performed for some values of the parameters. It is proved that the formula for ln Z as a function of temperature exhibits one point of discontinuity. (auth)

23137 TO THE PROBLEM OF CHARGE RADIATION IN NONEQUILIBRIUM MEDIA. Chugunov, Yu. V. (Gorky Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 108-13(1969). (In Russian).

The solutions for electromagnetic fields in nonequilibrium media are considered in the cases when the interaction between the uniformly moving charged particle and the packets of unstable oscillations of the given nonequilibrium system may be not taken into account. As a concrete example, the radiation reaction for a charge moving in mutual-penetrating media is considered. (auth)

23138 NONLINEAR INTERACTIONS IN QUANTUM PLASMAS. Wilems, Robert Edward. Knoxville, Tenn., Univ. of Tennessee, 1968. 165p.

Thesis.

Interactions of photons and fast electrons with plasmons in both bounded and unbounded systems are investigated within the framework of a quantum hydrodynamic model for the plasma. Plasmons in both perfect plasmas and plasmas containing structural imperfections are studied. Among the several interactions of photons with perfect plasmas examined are radiative damping of plasmons, resonance fluorescent scatter, second harmonic generation, and Raman scatter. The frequency shift of the radiative surface plasmon due to coupling with the radiation field is investigated, and resonance emission from photon-stimulated plasmons in imperfect plasmas and "grating" plasmas is also explored. Characteristic energy loss and gain by fast electrons through interaction with the plasmon field are studied. In addition, energy exchange through the plasmon field between various combinations of electrons and photons is examined. The process of "Auger" electron emission from a semi-infinite plasma through the de-excitation of electron-excited surface plasmons is also investigated. (Disser. Abstr.)

23139 THE PRODUCTION OF CONTINUOUS RADIATION IN PLASMA OF A POSITIVE RARE GAS COLUMN BY STOPPING OF ELECTRONS ON GAS ATOMS. Rutscher, A.; Peau, S. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Beitr. Plasmaphys., 8: 315-28(1968). (In German).

The continuum in the visible spectral region characteristic of the diffuse positive column of the rare gas discharge at average pressure was found to be a bremsstrahlung of the plasma electrons, which arise through interaction with the gas atoms. On the basis of a proportionality between the bremsstrahlung and the transport cross sections of the electrons, a calculation was made of the radiation intensity. The calculation comprehended quantitatively the observed dependence in the visible on the discharge parameters (gas pressure, current, and tube radius) and on the wavelength. The intensity variation between the rare gases investigated (He, Ne, Ar, Kr, and Xe) to be expected for an electron–atom bremsstrahlung corresponds to the experimental values. (tr-auth)

23140 FUNCTIONAL METHOD IN THE STATISTICAL MECHANICS OF PLASMAS. Dobbertin, Rolf (Institut Henri Poincare, Paris). Ann. Inst. Henri Poincare, Sect. A, 9: 45-87(1968). (In French).

A general kinetic equation is derived from Liouville's equation without any approximation. Then one gets special kinetic equations for systems with long and short-range interparticle forces by successive approximations of the general kinetic equation. The special kinetic equation is solved for a homogeneous fully ionized plasma under reasonable physical conditions; for this plasma, the electric conductivity for particles of finite size is calculated in the limit of point particles and high frequencies one finds the result of Oberman and Dawson and for zero frequency one gets the direct current result of Spitzer. Finally, the distribution of a finite system of charged particles in equilibrium for the rather particular case where the Debye sphere is greater than the sphere enclosing the system is calculated. (auth)

23141 INHOMOGENEITY CORRECTION OF THE KINETIC ENERGY OF A FERMION GAS. Gombas, P. (Univ. for Technical Sciences, Budapest). Phys. Lett., 28A: 585-6(Jan. 27, 1969).

For the inhomogeneity correction of a Fermion gas enclosed in a spherical shell it is shown that by adding the Fermi and Weizsäcker energy terms not the Weissäcker but the Fermi energy has to be decreased by a factor < 1. (auth)

23142 EVALUATION OF A MAGNETICALLY CONFINED LASER-CREATED PLASMA. Martineau, J.; Tonon, G. (CEA, Villeneuve-Saint-Georges, France). Phys. Lett., 28A: 710-11(Feb. 24, 1969).

Hydrodynamic equations are solved for a laser-created plasma, taking into account radial and axial megagauss field confinement. (auth)

23143 CRYSTALLIZATION OF A CLASSICAL ONE-COMPONENT COULOMB PLASMA. Van Horn, H. M. (Univ. of Rochester, N. Y.). Phys. Lett., 28A: 706-7(Feb. 24, 1969).

A calculation of the melting parameter Γ_m introduced by Brush et al., is given that is exact within the uncertainties in the Lindemann constant. The calculated result is $\Gamma_m = 170 \pm 10$. (auth)

23144 BASIC EQUATIONS FOR THE FREQUENCY COMPONENT OF THE ELECTRON VELOCITY DISTRIBUTION FUNCTION IN LORENTZ PLASMA UNDER THE INFLUENCE OF A PERIODIC ELECTROMAGNETIC FIELD OF TWO BASIC FREQUENCIES. Wilhelm, J.; Winkler, R. (Institut fuer Gasentladungsphysik, Greifswald, Ger.). Beitr. Plasmaphys., 8: 349-54(1968). (In German).

The development of the electron Boltzmann equation of a Lorentz plasma under bombardment of elastic and inelastic collisions was studied previously for any time- and site-dependent electromagnetic field. Because of the generalization of the fields considered, a development with respect to all directions in the velocity space was carried out by the orthogonal function system of the spherical surface function instead of development of the electron distribution function by Legendre polynomials. By use of a special tensor representation of the spherical surface function development of the distribution function, a compact tensor formulation of the Boltzmann equilibrium development can be obtained which in the special case of a homogeneous electrical field in the lowest approximation with respect to the mass ratios of the collision partner changes to the known Lorentz development of the distribution according to the Legendre polynomials. This general representation is quite valid in supplementary periodic Fourier development for obtaining in very compact form the basic equations for the frequency component of the distribution function of any interacting fields of two basic frequencies and to compile the equation systems already obtained in special cases. (tr-auth)

23145 DETERMINATION OF SOME THERMODYNAMIC CHARACTERISTICS OF MIXED-GAS PLASMAS. Fauchais, P.; Vasseur, A.; Manson, N. (Faculte des Sciences, Poitiers, France). Rev. Int. Hautes Temp. Refract., 6: 5-16(Jan.-Mar. 1969). (In French).

The calculation of thermodynamic properties of plasmas obtained by putting at high temperature a mixture of gas which may combine, dissociate, or ionize themselves, has been made with consideration, first to the macroscopic effect of Debye electrostatic interactions, and secondly to the influence of the limitation theory of sums of electronic states. As one noticed that the limitation theory is not applied in case of polyatomic molecules, a system of nonlinear equations was used which is an iterative method to obtain the plasma composition, for a given temperature and variation of ionization potential. Having no valid reasons to prefer one particular limitation theory, the calculus was programmed taking in consideration four limitation theories which seemed to be the most significant. The error that comes from the interpolation of values in many electronic states not well known yet were estimated. (auth)

23146 INVESTIGATION OF THE POSITIVE COLUMN OF NEON DISCHARGES AT AVERAGE GAS PRESSURES. PART I. Golubovskii, Yu. B.; Kagan, Yu. M.; Lyagushchenko, R. I.; Michel, P. (Leningrad State Univ.). Beitr. Plasmaphys., 8: 423-44 (1968). (In German).

The positive column of a neon discharge at average pressure was investigated. An approximate expression for the energy distribution function of the electrons is derived that is applicable in a broad discharge current density range. On the basis of the distribution function found, a diffusion theory of the positive column is developed. The electric field intensity, electron temperature, and electron concentration are calculated in dependence on the gas pressure, discharge current intensity, and radius of the discharge tube. The theory explains both the contraction of the column and its disappearance with reduction of the discharge current. (tr-auth)

23147 TRANSPORT COEFFICIENTS OF PARTIALLY IONIZED PLASMAS IN A MAGNETIC FIELD. Li, Chien-peng. Stanford, Calif., Stanford Univ., 1968. 115p.

Thesis.

Complete formulas for the calculation of the transport coefficients of a stable, multicomponent plasma in the presence of a magnetic and an alternating electric field are developed in accordance with the Chapman–Enskog theory. Simplifications in the Boltzmann equation arising from the small electron mass lead to a systematic reduction of the analysis. Expressions for the higher approximation can be worked out to any desired order by means of two algebraic relations for the bracket integrals. Special forms are then derived for application to computing the electron transport coefficients of laboratory plasmas where the species interact with realistic potentials. The rate of convergence of successive approximations is examined up to sixth order for the transverse and the Hall components of these coefficients. It appears that sixth approximation of the polynomial expansion scheme is well suited for plasmas in an electromagnetic field, but higher approximation is needed to account for the electron–atom Ramsauer phenomenon. On the other hand, less-exact methods such as the Frost mixture rule and the perturbation method have been extended to the calculation of thermal conductivity parallel to the field. Although these methods are empirical in nature, the results of the former are found to agree within 10% with the prediction of the sixth Chapman–Enskog approximation at any degree of ionization. The perturbation method shows limited application but yields highly accurate results for weakly ionized plasmas. Numerical values of electrical and electron thermal conductivities for helium and argon are evaluated by the three methods mentioned above and are compared. (Disser. Abstr.)

23148 THEORY OF LINE SHAPES. Bezzerides, Bandel (Univ. of California, Livermore). Phys. Rev., 181: 379-99 (May 5, 1969).

The theory of absorption line shapes is reviewed as a special case of the kinetic theory of gases. Correspondence with low-frequency transport results in corrections to the impact theory and the statistical theory of line broadening. These corrections are observed to be related to the general question of non-Markovian effects in kinetic theory. The various classifications of line broadening are described in terms of the most important driving mechanisms of the absorbing atom distribution function and the damping mechanisms due to collisions. High-frequency transport on the other hand suggests a modification of the correlation function approach closely related to the results of elementary scattering theory. The wing spectrum of a line may thus be analyzed in terms of the relevant microscopic collisional rates. (auth)

23149 MACROSCOPIC QUASILINEAR THEORY OF HIGH-FREQUENCY RADIATION IN A COLD PLASMA. Taussig, Robert T. (Harvard Univ., Cambridge, Mass.). Phys. Fluids, 12: 914-22(Apr. 1969).

The nonlinear fluid equations for a cold electron–proton plasma are averaged over short time and length scales to obtain high-frequency "radiation" terms as well as the usual macroscopic electromagnetic fields. The result is a self-consistent, quasilinear theory in which the radiation terms can be calculated directly from the plasma equations and Maxwell's equations without reference to an independent radiative transfer equation. Mechanisms for the nonlinear saturation of the absorption of resonant modes of radiation field can be included in the formulation by introducing a small, finite temperature. When the plasma is steady, uniform, and nonstreaming, with no applied fields, it is possible to derive a radiative intensity function which includes the collective effects of the plasma and obeys an integral form of the classical radiative transfer equation. However, in general there are averaged, high-frequency terms which have no counterpart in the usual radiation theory. These new radiation terms come from waves in the presence of applied magnetic fields or macroscopic nonuniformities in the plasma. (auth)

23150 ONE-DIMENSIONAL FREE EXPANSION OF A COLLISIONLESS PLASMA. Hiroshige, Yasushi (McDonnell Douglas Corp., Long Beach, Calif.); Yang, H. T. Phys. Fluids, 12: 923-34(Apr. 1969).

The free expansion of a plasma is usually pictured as a combination of free-streaming ions and an oscillating electron fluid. This conjecture is tested for the one-dimensional expansion of a collisionless plasma initially in thermal equilibrium and confined between two perfectly reflecting planes and then with the right one removed. Two methods of solution are used. The first is an approximate method based on Vlasov's equations and the second is a computer experiment employing the sheet model. The two methods show good agreement in the zeroth-order motion to the end of the computer run which is about 4 electron plasma periods or 0.75 ion plasma period for the mass ratio used. The behavior of the ion follows the center of mass of the plasma which is acted on by the sum of electron and ion pressures. The electron follows a damped sine wave at the electron plasma frequency, with the amount of damping dependent upon the decrease in the pressure at the left boundary. (auth)

23151 PARTITION OF ENERGY IN A TURBULENT PLASMA. Robinson, D. C.; Rusbridge, M. G.; Saunders, P. A. H. (Culham Lab., Abingdon, Eng.). Plasma Phys., 10: 1005-23(Nov. 1968).

A theory is developed which leads to an expression for the partition of energy between mechanical and magnetic modes in a turbulent magnetohydrodynamic system in the presence of a strong external field. Modifications to this expression due to specific plasma effects are obtained and are not significant. Results are also obtained for the frequency spectra and diffusion coefficient. Measurements of the turbulent fluctuations in the Zeta device are described, and from these, values for the partition are obtained. It is found that there is only complete agreement with the theory if an anomalous resistivity is assumed at low operating pressures. (auth) (UK)

23152 INTERACTION OF A SYSTEM OF HIGHLY RELATIVISTIC ROTATING ELECTRONS AND A COLD MAGNETOACTIVE PLASMA. Fung, P. C. W. (Univ. of Montreal). Plasma Phys., 10: 993-1003(Nov. 1968).

The possibility of exciting synchrotron radiation in a system of highly relativistic monoenergetic electrons rotating in a cold collisionless magnetoactive plasma is discussed. For such a system of relativistic rotating electrons and background plasma, the temporal growth rate for synchrotron radiation is derived for general direction of observation. Evaluation of the growth rate is carried out for some parameters of interest. The spatial amplification rate of the wave is also deduced. (auth) (UK)

23153 PAIR DISTRIBUTION FUNCTION OF CHARGED PARTICLES. del Rio, Fernando (Instituto Mexicano del Petroleo, Mexico City); DeWitt, H. E. Phys. Fluids, 12: 791-8(Apr. 1969).

The pair distribution function for a classical one-component plasma is obtained by summing terms of the Montroll–Mayer cluster expansion of g(r) as modified by Meeron and Hirt for the Coulomb potential. A simple class of diagrams in this nodal expansion gives the asymptotic form of g(r) for long distance as a modified Debye form. Results are obtained exact to $O(\Lambda^2 \log \Lambda)$ where $\Lambda = 1/4\pi n\lambda_D^3$ is the plasma parameter. The analysis shows that for Λ larger than a critical value Λ_c the long-distance form of g(r) changes from the Debye form to a damped oscillatory form in qualitative agreement with the Monte Carlo calculations of Brush, Sahlin, and Teller. Numerical calculations done on the simplest form of the result agree moderately well with the Monte Carlo results over the entire range of r for $\Lambda \leq 2$, and represent a substantial improvement over the nonlinear Debye–Hückel result. (auth)

23154 COLLISION OPERATOR FOR A RELATIVISTIC LORENTZ GAS. Kelly, Don C. (Miami Univ., Oxford, Ohio). Phys. Fluids, 12: 799-803(Apr. 1969).

The elastic collision operator for a relativistic Lorentz gas is converted to differential form. The Fokker–Planck "limit" is deduced. The Fokker–Planck form is obtained for a relativistic electron–ion gas. Possible implications for a relativistic plasma are discussed. (auth)

23155 FLUCTUATIONS IN MONATOMIC GASES. Montgomery, David (Univ. of Iowa, Iowa City). Phys. Fluids, 12: 804-9(Apr. 1969).

The problem of calculating distribution-function autocorrelations of the form $\langle f(x_1, v_1, t_1)\, f(x_2, v_2, t_2)\rangle$ is treated for a dilute monatomic gas. Two-time probability distributions of the type introduced by Rostoker for the plasma case are used. A perturbation expansion in the density is performed on the generalized BBGKY hierarchy which results. It is shown that the problem of determining the fluctuation spectra can be reduced to solving for a function which obeys the linearized kinetic equation for a dilute neutral gas with a particular choice of initial conditions, a result previously obtained by van Leeuwen and Yip, using diagrammatic perturbation theory. In the limit of infinite wavelengths and hard-sphere interactions, this equation reduces to the linearized Boltzmann equation. (auth)

23156 SMALL-AMPLITUDE PHENOMENA IN CONDUCTING FLUIDS AND TRANSPORT PROPERTIES OF PLASMAS. Uberoi, C. Bangalore, Indian Institute of Science, 1966. Thesis

The following problems are described: (1) Gravitational instability of an infinitely extending layer of finite thickness in the presence of magnetic field and hall current. (2) Transverse plasma oscillations excited by interpenetrating beams of positively and negatively charged particles moving between two parallel nonconducting planes. (3) Magnetohydrodynamic waves in (a) ideally conducting uniform medium with inhomogeneous magnetic field having the same direction, (b) in a finitely conducting medium taking into account the anisotropy of the medium introduced by the presence of a magnetic field through Hall currents, (c) in a cylindrical plasma in the presence of uniform axial magnetic field and a steady axial current taking into account the finite amplitude in a limited way. (4) Evaluation of the transport properties of a plasma consisting of electrons, positively charged particles and neutral atoms such as viscosity, heat and electrical conductivity, and so on in the presence of a uniform magnetic field. The basic model underlying these investigations is the BGK model. (Indian Sci. Abstr.)

Production

23157 (AD–672964) EFFICIENCY ESTIMATES FOR CONVERSION OF FOCUSED LASER RADIATION TO X RAYS IN A HOT DENSE PLASMA. Bernstein, Melvin J.; Comisar, Gerald G. (Aerospace Corp., El Segundo, Calif.). Mar. 1968. Contract F04695-67-C-0158. 20p. (TR–0158(3220-50)-4; SAMSO-TR-68-212). CFSTI.

The report examines the feasibility of using focused laser radiation to generate a dense high-temperature plasma in the keV range that will reradiate a significant amount of the absorbed energy as high-energy photons. The difficulty is that the plasma expands more rapidly as the temperature is increased, thereby diminishing the plasma radiation rate, which depends on the free electron density. The total radiation will be on the order of two to three times that of bremsstrahlung alone and will consist primarily of photon energies that are less than an energy corresponding to the plasma temperature. For a temperature of several keV, the plasma will expand within a few tenths of a nanosecond, requiring that the lasers have equally short pulses for optimum use of the laser energy. The frequencies of Nd-glass lasers and ruby lasers correspond to maximum electron densities of about 1 to 2 × 10^{21}/(cu cm), and estimates place the emitted x radiation at around 1 to 2% of the energy absorbed in a fraction of a nanosecond. Use of frequency-doubling crystals or creation of high-power ultraviolet lasers would increase the efficiency by up to an order of magnitude. (USGRDR) (auth)

23158 (CEA-R-3472) CONTRIBUTION TO THE STUDY OF THE IONIZATION AND HEATING OF GASES BY LASER RADIATION. Veyrie, Pierre (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). 1968. 89p. (In French). Dep.

Thesis. Submitted to Paris Univ., France.

The ionization and heating of gases by the concentrated radiation of a neodymium laser is studied. The power is 300 MW, the gas studied is primarily deuterium between 300 mm and 2280 mm. The first part concerns a certain number of experimental results on the absorption of the radiation and on changes produced in the plasma as a function of time. From these results are deduced a certain number of consequences, among which may be mentioned the definition of a pre-ionization threshold. These experimental results are interpreted in the second part. A calculation is made of the length of the period during which the electrons multiply up to when the absorption becomes measurable. The last phase corresponds to the hydrodynamic evolution. The calculations are compared with the experiments. The agreement between theory and experiment is satisfactory for the different phases. (auth)

23159 (IPP-3/81) OPTICAL CONSTANTS OF FULLY IONIZED PLASMAS FOR THE RADIATION OF RUBY, NEODYMIUM-GLASS, AND CO_2 LASERS. Hora, Heinrich; Mueller, Hannelore (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov. 1968. 35p. (IPP-6/71). Dep.

The refractive index n and the absorption constant K are numerically evaluated for fully ionized plasmas with atomic numbers Z = 1 to 4 as functions of the electron temperature T and atomic density N for the case of ruby, neodymium-glass, and CO_2 laser radiation and for the second harmonics of each type of radiation on the basis of the two-fluid model of hydrodynamics using Spitzer's collision frequency ν. (auth)

23160 (IPP-3/82) FOCUS DETECTOR AS AN AID FOR FOCUSING A LASER ON A TARGET. Buechl, K. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec. 1968. 15p. (In German). Dep.

An apparatus that assesses the focus of a laser on a surface is described. An image of the focus is scanned by fiber optics. A moving slit, together with a photodetector behind the fibers, detects whether a fiber is illuminated or not. When the focus coincides with the surface of the target, the number of illuminated fibers is a minimum. The apparatus is especially advantageous for adjustment when the radiation is not visible, for example, with neodymium lasers or with frequency-doubled radiation from ruby lasers. (auth)

23161 NUMERICAL CALCULATIONS OF THE DYNAMICS OF A LASER-IRRADIATED SOLID HYDROGEN FOIL. Mulser, P.; Witkowski, S. (Institut fuer Plasmaphysik, Munich). Phys. Lett., 28A: 703-4(Feb. 24, 1969).

Numerical results are presented for a gasdynamic model of a solid hydrogen foil, which is irradiated by a laser. The compressibility of the solid and the heat conductivity was included. The influence of the compressibility on the ejected plasma is discussed. (auth)

23162 OPTICAL ABSORPTION AND EXPANSION OF LASER-PRODUCED PLASMAS. Dawson, J.; Kaw, P.; Green, B. (Princeton Univ., N. J.). Phys. Fluids, 12: 875-82(Apr. 1969).

Calculations of the absorption of laser radiation by an inhomogeneous overdense plasma have been carried out. Such a plasma is produced when a high-powered laser irradiates a solid particle. Nearly complete absorption is found as long as 2R is greater than $c\tau$; here, R is the scale length for density falloff, c is the velocity of light, and τ is the electron-ion collision time for a plasma frequency equal to the incident laser frequency. For hydrogen this gives complete absorption up to temperatures of 5 keV if R is greater than 5×10^{-2} cm; higher Z materials absorb better. The expansion of a laser-produced plasma was also investigated. In the case of a plasma produced from a thin metallic film, it is found that the expansion preferentially takes place normal to the film which is in agreement with observation. (auth)

Stability

23163 (CEA-R-3680) EXPERIMENTAL STUDY OF AN ION CYCLOTRON INSTABILITY IN A MAGNETIC WELL CONFINED PLASMA. Brossier, Philippe (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 170p. (In French). (EUR-4110). Dep.

Thesis. Submitted to Paris Univ., France.

This report is a contribution to the study of microinstabilities in macroscopically stable plasmas, in the low-β limit. Ion cyclotron instabilities, with $k_{\parallel} = 0$, have been numerically studied in detail; the computation of the density thresholds and growth rates of the different harmonics showed the relative role played by the following: density gradient, perpendicular distribution function, and cold plasma component. This theoretical model has been compared with the results of a detailed study (density thresholds, wave structure, frequency spectrum, wavelengths, growth rate, amplitude of the electric field) of the instability observed in the DECA II device. This comparison gave a good agreement which shows the destabilizing role played by the cold plasma component on a hot plasma with a loss cone distribution function. (auth)

23164 (IPP-3/84) TOROIDAL EQUILIBRIUM WITH TEMPERATURE GRADIENTS. Feneberg, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jan. 1969. 31p. (In German). Dep.

The first part of this work deals with a model steady-state plasma in the toroidal magnetic field of Tokamak geometry ($\beta \ll 1$) in which a temperature gradient forms as a result of the input energy being transported to the wall by thermal conduction. There is a region where the thermal conductivity parallel to the field lines is sufficiently high to keep the temperature constant in zeroth order on a magnetic surface. In this region the energy equation can be expanded and the temperature profile can be obtained from an ordinary second-order differential equation, just in a linear discharge. In the toroidal case, however, the thermal conductivity is increased by the amount $(4\pi^2/\iota^2)$ $(2\pi/\iota$ is the rotational transform) compared with the linear case. The density profile can be derived from a solubility condition that has to be imposed on the equation of continuity. The thermal diffusion coefficient thereby plays an important part in Ohm's law because it establishes a relation between the density and temperature gradients. (auth)

23165 (IPP-6/68) NONLINEAR INSTABILITY IN TWO-DIMENSIONAL PLASMA CONFIGURATIONS. Wobig, H.; Pfirsch, D. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug. 1968. 28p. Dep.

Two-dimensional collisionless plasmas in which the distribution functions depend only on the energy and canonical momentum of the third space coordinate ($f = f(E,P_3)$) can become unstable due to the tearing-mode instability. The linear theory of the collisionless tearing mode is extended to two-dimensional configurations. If the distribution function $f(E,P_3,\alpha)$ depends continuously on a parameter α there can be several solutions for the fields at the same α and a bifurcation point $\alpha = \alpha_0$ of the equilibrium owing to the nonlinearity of the equilibrium equations. The linear theory shows that the bifurcation point is also a transition point of the stability ($\omega = 0$). Using an amplitude expansion the stability of the equilibria is investigated in the neighborhood of the bifurcation point. It was found that, in this case, a linearly stable system may be unstable with respect to finite perturbations. The theory is next applied to a plasma configuration with an x-type neutral point of the magnetic field. The electric field is neglected. Instabilities are found if there is a minimum of the pressure on the separatrix. It exists a critical minimum pressure below which the system is linearly unstable, but it is already unstable for finite perturbations above this critical pressure. Such explosive behavior of an instability may be of interest in some astrophysical phenomena. (auth)

23166 (LA-4088) STABILITY OF THE DENSE PLASMA FOCUS. Mather, Joseph W.; Bottoms, Paul J.; Carpenter, James P.; Williams, Arthur H.; Ware, Kenneth D. (Los Alamos Scientific Lab., N. Mex.). Jan. 15, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

The influence of small dc "axial" magnetic fields upon the stability of a focused plasma column is shown by use of soft x rays. Material damage to the center electrode and the intense x-ray emission at the electrode face resulting from electron bombardment are considerably reduced. Although the final heating of the ions and electrons is inhibited as expected owing to a trapped magnetic field, the spatial stability of the focused column offers greater possibility for scaling to higher energies. (auth)

23167 (LA-4107) THE KELVIN-HELMHOLTZ INSTABILITY IN A FLOWING PLASMA. Suydam, B. R. (Los Alamos Scientific Lab., N. Mex.). Feb. 3, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

In the continuously flowing pinch the effect of shear in the velocity field on interchange stability is of some importance. The normal mode equations were examined in the limit of negligible cylindrical curvature (equivalent to plane flow) and in the limit of dominant cylindrical curvature. These two limiting cases give very similar results and show that the development of the Kelvin-Helmholtz instability does not depend merely on the presence of shear but rather on the details of the velocity profile. The study seems to indicate that the instability develops only if there is a layer of high shear between two layers of lower shear. These results correct erroneous statements about the effect of shear made in Los Alamos Report LA-4034-MS. (auth)

23168 (RISO-187) STABILITY OF A ROTATING PLASMA. Milantiev, V. P.; Oester, Flemming (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan. 1969. 22p. Dep.

The stability of rotating plasmas is investigated. The two-fluid description of a plasma in the "flute approximation" is used. General equations, valid for arbitrary density distributions and for nonuniform rotation, are derived. The equations are solved for several special cases. When the drift velocity is comparable to the thermal velocity, the finite Larmor radius corrections can be neglected. For that case, explicit stability conditions valid for various density distributions and for nonuniform rotation are given. (auth) (Denmark)

23169 STABILITY LIMITATIONS FOR STELLARATORS WITH SHARP SURFACES. Rosenbluth, M. N.; Johnson, J. L.; Greene, J. M.; Weimer, K. E. (Princeton Univ., N. J.). Phys. Fluids, 12: 726-8(Mar. 1969).

Application of the magnetohydrodynamic energy principle to a stellarator equilibrium where the plasma pressure is constant inside a bounding magnetic surface shows that the configuration is unstable to a nearly rigid shift of the plasma column. (auth)

23170 COMPUTER EXPERIMENTS ON PLASMA INSTABILITIES DUE TO ANISOTROPIC VELOCITY DISTRIBUTIONS. Okuda, Hideo; Hasegawa, Akira (Osaka Univ., Toyonaka, Japan). Phys. Fluids, 12: 676-86(Mar. 1969).

Computer experiments on plasma instabilities due to anisotropic velocity distributions are made to study nonlinear phenomena as well as the validity limit of linear theory using a sheet plasma model. Three kinds of anisotropic distributions are considered; type-A, perpendicular (to an applied magnetic field) velocity distribution function having a hump at $v_\perp \neq 0$, type-B, bi-Maxwellian distribution with $T_\perp \gg T_{||}$, and type-C, loss-cone distribution. Results of the experiments show that instability due to type-A distribution is generally very strong and resembles two-beam instability. One of the characteristics of this is that the strength of the instability is relatively insensitive to the propagation angle. On the other hand, instability due to type-B distribution is quite sensitive to the propagation angle. A particular feature of the type-B instability is that, in addition to a growth that is predicted by linear theory, there exist several strong bursts which play an essential role in accelerating plasma along magnetic field lines. After the bursts, the plasma arrives at a stable state with a much reduced ratio of $T_\perp/T_{||}$ compared with that at the initial state. Another interesting instability is the loss-cone instability which is caused by the type-C distribution, an inherent distribution in a mirror magnetic field. When a disturbance propagates almost perpendicularly to magnetic field, an instability is shown to develop due to a coupling of hot ions with cold electrons. With the development of the instability, ions are accelerated along the magnetic field lines and are gradually lost from the mirror field. (auth)

23171 RADIATION-INDUCED DECAY INSTABILITY OF BERNSTEIN MODES. Stern, R. A. (Bell Telephone Labs., Whippany, N. J.). Phys. Rev. Lett., 22: 767-70(Apr. 14, 1969).

Intense excitation of Bernstein modes with $\vec{k} \perp \vec{B}$ by means of nonlinear coupling to a higher-frequency mode at the sum frequency has been observed. (auth)

23172 EXPERIMENTS ON RESISTIVE INSTABILITIES IN A TOROIDAL PLASMA. Stuart, Kenneth. Brooklyn, Polytechnic Inst., 1968. 148p.
Thesis.

The experimental setup consists of a plasma-filled ring-shaped container of rectangular cross section, where a discharge is induced by means of an iron-cored transformer. The time development of the current distribution in the plasma is determined with the help of a combination of magnetic probes and an S.T.L. Image Converter Camera. Optical spectroscopy is used to calculate the temporal variation of electron number density and temperature. It is found that the plasma forms near the inner cylindrical wall, where the primary winding is located, and moves radially outward as time progresses. The radial speed depends on the mass density and magnetic field associated with the plasma in accordance with the snowplow model. Concurrently with the outward motion a resistive instability develops, which breaks the current sheet into separate rings. The wavelength of the instability and therefore the number of rings depend on the geometry of the primary winding and on the initial perturbation it introduces in the field distribution. It was found that for a primary winding having N equal segments, the initially uniform plasma sheet split into N + 1 rings. Theory predicts that the "tearing" and "rippling" modes of a resistive instability develop with an exponential growth rate that is a function of the resistivity, mass density, magnetic flux density, and plasma thickness. The experiments confirm this functional dependence. Also consistent with the theory is the influence of wave number on the growth rate for the two modes mentioned above. (Disser. Abstr.) (TSS)

23173 PHYSICAL MECHANISM FOR THE COLLISIONLESS DRIFT WAVE INSTABILITY. Meade, D. M. (Univ. of Wisconsin, Madison). Phys. Fluids, 12: 947-8(Apr. 1969).

The growth rate for the collisionless drift instability is calculated in a manner which elucidates the physical mechanism for the instability. (auth)

23174 ION FLUTE MODE WITH TEMPERATURE GRADIENTS. Malik, S. K. (Univ. of Wisconsin, Madison). Phys. Fluids, 12: 942-4(Apr. 1969).

The effect of temperature gradients on the ion flute mode is investigated using the slab model with periodic varying gravity to simulate the effect of magnetic curvature and the condition for the instability is obtained. (auth)

23175 COLLISIONLESS TEARING MODE INSTABILITIES IN A HIGH-β THETA PINCH. Freidberg, J. P. (Los Alamos Scientific Lab., N. Mex. United Kingdom Atomic Energy Authority, Abingdon, Eng.); Morse, R. L. Phys. Fluids, 12: 887-94(Apr. 1969).

The stability of a high-β theta pinch against tearing modes is investigated using the Vlasov equations in both slab and cylindrical geometries. For the slab case it is shown that necessary and sufficient condition for stability of one-dimensional equilibria is that the magnetic field have no field reversal. For the cylindrical case the stability condition is more stringent; that is, all field configurations with reversals are unstable. In addition, because of the destabilizing effect of rotation, the magnetic field must be sufficiently positive biased in order to achieve stability. When interpreted in terms of the density profile, the stability criterion is equivalent to the condition that profiles with a density maximum on axis are stable while those with a density maximum off axis are unstable. (auth)

23176 NONLINEAR THEORY OF THE E x B INSTABILITY. Kim, John J. (Univ. of Rochester, N. Y.); Simon, Albert. Phys. Fluids, 12: 895-900(Apr. 1969).

A weakly ionized plasma will go unstable in the presence of a density gradient and parallel electric field, both at right angles to a magnetic field, if the electric field is of the right sign and sufficiently large. The nonlinear limit of the first mode to go unstable when E is increased is determined as a function of Δ [$\Delta \equiv (E - E_c)/E_c$]. A general theory of this small amplitude behavior is used. The mode amplitude, frequency shift, density flattening, electric field change, and anomalous plasma transport are obtained as functions of Δ. It is shown that mode coupling corrections are small, and hence that the quasilinear result is sufficient. (auth)

23177 INSTABILITIES ARISING FROM BEAM-PLASMA INTERACTION. Yamamoto, Takayoshi; Suita, Tokuo. Technol. Rep. Osaka Univ., 18: 325-38(Oct. 1968).

Injection of a modulated electron beam into a plasma causes remarkable amplification of the rf signals when the modulation frequency approaches the plasma frequency. The observed growing wave is regarded as the convective instability that is restrained to a finite amplitude owing mainly to the collisional damping effect. The growth rates calculated from the dispersion relation including only the collision effect coincide with the experimental results to a satisfactory extent. (auth)

23178 CUSP CURVATURE STABILISATION OF UNIVERSAL MODE. Saison, R. (Institut fuer Plasmaphysik, Munich). Plasma Phys., 10: 927-30(Oct. 1968).

A sufficient stabilization criterion of the universal mode is obtained for true curvature. Comparison with other studies shows that simulating the curvature overestimates stability, while neglecting the statistical dispersion of the drift velocities underestimates it. (auth) (UK)

23179 EFFECT OF BOUNDARY CONDITIONS ON THE STABILITY OF A NONUNIFORM PLASMA IN A MAGNETIC FIELD. Lashmore-Davies, C. N. (Culham Lab., Abingdon, Eng.). Phys. Rev., 181: 437-42(May 5, 1969).

The propagation of high-frequency electrostatic waves is considered in a plasma in which there is a zero-order temperature gradient perpendicular to the uniform magnetic field. The frequency range is such that the ions do not respond to the perturbed fields (this condition is satisfied if $\alpha/\rho_i \ll k_\perp d$ resulting in $\omega \gg \omega_{ci}$, $\omega \gg \omega_{pi}$, where ω_{ci} and ω_{pi} are the ion-cyclotron and ion-plasma frequencies and α, ρ_i, $k_\perp$, and d are the scale length of the temperature gradient, the ion Larmor radius, the perpendicular component of the wave vector, and the electron Debye length, respectively). For $\omega \ll \omega_{ce}$, $\rho_e \ll d \ll \lambda_\perp$ and a specific form of the temperature gradient the differential equation for φ is reduced to an elementary form where ω, ω_{ce} are the wave- and electron-cyclotron frequencies and $\lambda_\perp$ and ρ_e the wavelength perpendicular to the uniform magnetic field and the electron Larmor radius, respectively. φ is the electrostatic potential. For $\lambda_\perp \ll \alpha$ the exact solution is very close to the local solution of Mikhailovskii and Pashitskii which neglects the effects of the boundaries. However for $\lambda_\perp \gtrsim \alpha$ the plasma is unstable to shorter axial wavelengths than predicted by the local theory. It is shown that the instability is due to the interaction of a positive energy wave with a negative energy wave. When the phase velocities of the two waves are different the plasma is stable. However, when the nonuniform plasma is adjacent to a cold resistive plasma, instability may again result. This is analogous to the resistive wall amplifier of Birdsall, Brewer and Haeff. The relevance of these results to the stability of low frequency waves in a nonuniform plasma is pointed out. (auth)

Thermonuclear Processes

23180 (SC-DC-69-1648) PULSED POWER FROM EXPLOSIVE GENERATORS. Cowan, M.; Cnare, Eugene C. (Sandia Labs., Albuquerque, N. Mex.). Apr. 1969. 17p. (CONF-690407-2). Dep. CFSTI.

From Symposium on Engineering Problems of Fusion Research, Los Alamos, N. Mex.

For the past few years, explosive generators have undergone engineering development in connection with experimental programs being carried out at Sandia Laboratories. As a result, this technology has taken on a versatility not previously extant. Explosive generators may now be considered competitive with capacitor banks as a source of pulse power for a larger range of applications. Recent developments in characterizing performance capabilities of explosive generators along with techniques which extend the capabilities of a given generator design will be presented. A new explosive generator facility which allows isolation of the high-explosive effects will be described. (auth)

23181 (UCRL-50544) EXPERIMENTS AND CALCULATIONS ON THE FEASIBILITY OF PUMPING LIQUID LITHIUM IN A THERMONUCLEAR REACTOR BLANKET. Wells, William M. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 3, 1969. 26p. Dep. CFSTI.

A number of experiments were conducted in which liquid mercury in a 4-in.-square duct was moved into a magnetic field from a region without a magnetic field. The experiments were repeated with a low-melting-point alloy in its solid state. The resulting data are compared with analytical predictions and with a limited amount of data from other workers. Implicit in the work reported is the strong dependence of pressure drops on the length of the entry to the magnetic field. Under the assumption of electrically insulating walls, the pressure drops for liquid lithium in a hypothetical thermonuclear reactor are estimated in transition and uniform-field regions. It is concluded that these losses are readily tolerable and hence that liquid lithium cannot be dismissed from consideration solely on the grounds that excessive pumping power would be required. (auth)

23182 (UCRL-71525) CONSTANT VOLTAGE PULSE OUTPUT SOURCE STUDY. Headley, Francis B. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 21, 1969. 10p. (CONF-690407-3). Dep. CFSTI.

From Symposium on Engineering Problems of Fusion Research, Los Alamos, N. Mex.

Possible methods of maintaining a constant, or nearly constant, magnitude of the pulsed magnetic field within a pulsed coil were studied. The two most promising are examined in more detail in this paper. The 2X Multi-Stage Plasma Compression Facility was used for the study comparison. The characteristics studied include resistance (R), 1 m Ω; inductance (L), 10 μH, and the corresponding time constant (TC), 10,000 μsec. This value is theoretical and would be attainable only if the crowbar circuit were to have negligible resistance and inductance. A pulse forming network (PFN) appears to be the least expensive means of maintaining a constant magnitude pulsed magnetic field. Furthermore, an impulse-operated mechanical crowbar switch connected across the coil may readily be included to prolong the pulse by forcing the field to decay slowly at the time the PFN voltage is at the point of decaying. (auth)

23183 (UCRL-71536) CRYOGENIC ASPECTS OF BASEBALL II. Nelson, Robert L. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 1, 1969. 11p. (CONF-690407-11). Dep. CFSTI.

From Symposium on Engineering Problems of Fusion Research, Los Alamos, N. Mex.

This report covers the design of the cryogenic system required for operation of the superconducting baseball magnet now under construction at LRL. It includes a detailed analysis of the heat leak into the system as well as discussion of the shielding and magnet support techniques used to minimize this heat leak. Other problems considered are the magnet cooldown and thermal stresses encountered during the cooldown operation. Schematics of the closed helium cycle and the associated refrigerator and helium recovery system are also included. (auth)

23184 (UCRL-71540) FABRICATION TECHNIQUES FOR RECENT COMPLEX MAGNET SYSTEMS. Harvey, A. R. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 27, 1969. 17p. (CONF-690407-9). Dep. CFSTI.

From Symposium on Engineering Problems of Fusion Research, Los Alamos, N. Mex.

Within recent years magnetic field requirements have fostered magnet systems of ever increasing complexity. Large superconducting magnets with nonconventional geometries, lumped solenoids that produce fields of high uniformity, and solenoids requiring greater heat dissipation properties present fabrication problems not heretofore encountered. Magnets of this type or their prototypes are currently being constructed in the magnet fabrication facility at Lawrence Radiation Laboratory, Livermore. Some of the difficulties encountered and the techniques developed for the design and fabrication of a single magnet system are reported. (auth)

23185 (UCRL-71541) ON-OFF LIQUID HELIUM CRYOPUMP. Denhoy, Balwant S.; Batzer, Thomas H. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 1, 1969. 9p. (CONF-690407-8). Dep. CFSTI.

From Symposium on Engineering Problems of Fusion Research, Los Alamos, N. Mex.

An on-off thermal switch for thermally isolating the liquid He storage from the pumping surface is incorporated into a cryopump, which results in an increased pumping rate and efficiency as well as less-hazardous operating procedures. The switch is a hermetic volume between the LHe storage and the pumping surface. Gas is introduced into the insulating space to establish thermal contact between the LHe and the pumping surface; then the gas is evacuated to thermally isolate the pumping surface. (auth)

23186 (UCRL-71543) THE 2X VACUUM SYSTEM. Anderson, C. J. (California Univ., Livermore. Lawrence Radiation Lab.). [1969]. 12p. (CONF-690407-4). Dep. CFSTI.

From Symposium on Engineering Problems of Fusion Research, Los Alamos, N. Mex.

The 2X vacuum system equipment and method of operation are described. Operating pressures of the order of 2 to 3×10^{-9} torr and base pressures of the order of 5 to 8×10^{-10} torr are obtained in a mildly baked aluminum and glass vessel of 11,000 liters. Seals are aluminum foil, TFE, Hycar, and epoxy. Titanium sublimation onto LN_2 cooled liners is used with mercury diffusion pumping. The nature of the resulting vacuum is discussed with particular regard to the predominant residual gas methane. (auth)

23187 (UCRL-71570) A HIGH PERFORMANCE, PROGRAMMABLE, 25-kV, 2-A POWER SUPPLY. Waugh, A. F. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 20, 1969. 13p. (CONF-690407-15). Dep. CFSTI.

From Symposium on Engineering Problems of Fusion Research, Los Alamos, N. Mex.

The performance, circuit, and construction features of a 50-kW, HV, precision programmable voltage-regulated, dc power supply are described. This system is used as a HV power supply for an ion source. Its high voltage output is applied across the extraction apertures of the ion source to create the high field gradient required to extract an ion beam from the source plasma discharge chamber. The output voltage is adjustable from 200 V to 25 kV. The maximum continuous load current is 2 A. The output voltage is regulated to within ±0.05% for ±5% line and ±10% load changes. The peak-to-peak output ripple and noise do not exceed 5 V. An adjustable current limit feature causes the regulator system to instantaneously change from voltage regulating mode to current limiting mode at the current limit set point. It is possible to modulate or program the output HV from a low-level input signal with a gain of 1000. The output may be modulated to a peak-to-peak amplitude of 20 kV at up to 100 Hz and for linearly decreasing amplitude vs. frequency down to 100 V at 10 kHz. All of the regulation and control is done by a single water-cooled power-tetrode series pass tube in the HV output line. The remainder of the control circuitry consists of pc-board-mounted solid-state components and discrete circuit elements. The grid of the HV regulator tube is driven by a single power transistor. A key component in the regulator loop is a photon-coupled isolator. This wide-bandwidth, signal-coupling element consists of a gallium arsenide electroluminescent diode infrared source and a silicon PIN photodetector. This device is used to couple the output of the ground potential regulator amplifier up to the series pass-tube control circuit which is floating at the output high voltage. (auth)

23188 THERMONUCLEAR PROSPECTS OF MAGNETIC CONFIGURATIONS OF THE TOKAMAK TYPE. Hubert, Pierre (EURATOM–CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser. A, B, 268: 603-6(Feb. 24, 1969). (In French).

Experiments of plasma confinement in apparatus of the Tokamak type were the object of theoretical works, and are interesting to compare with the technological requirements of an eventual thermonuclear reactor. The existence of a small internal region in which two points of view can be eventually reconciled is shown in this note. (tr-auth)

23189 CONTINUOUS SUPERSONIC PLASMA WIND TUNNEL. Andersen, S. A. (Research Establishment Risoe, Roskilde, Denmark); Jensen, V. O.; Nielsen, P; D'Angelo, N. Phys. Fluids, 12: 557-60(Mar. 1969).

The normal magnetic field configuration of a Q device has been modified to obtain a "magnetic Laval nozzle." Continuous supersonic plasma "winds" are obtained with Mach numbers ~3. The magnetic nozzle appears well suited for the study of the interaction of supersonic plasma "winds" with either material or magnetic obstacles. (auth)

Wave Phenomena

23190 (FTI–104) ABSORPTION OF ELECTROMAGNETIC WAVES IN A STRONGLY INHOMOGENEOUS PLASMA. Piliya, A. D.; Fedorov, V. I. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1968. 13p. (In Russian). Dep.

A layer of cold, collisionless plasma with concentration depending on one coordinate x in a homogeneous external magnetic field is considered for solution. The wave vector is perpendicular to the concentration gradient. The magnetic field is at an arbitrary angle to the concentration gradient. The wave equation is written, and dimensionless terms are introduced. The set of equations are solved in explicit form for small layer thicknesses by replacement by an equivalent integral equation and solving by successive approximations. The power adsorbed by unit surface of the layer is then determined in the region of frequencies where strong absorption is to be expected. An expression is also obtained for maximum absorption. (TTT)

23191 (FTI–144) LINEAR TRANSFORMATION OF WAVES IN AN INHOMOGENEOUS MAGNETOACTIVE PLASMA. Piliya, A. D.; Fedorov, V. I. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnischeskii Institut). 1968. 16p. (In Russian). Dep.

As is known, the electric field of a wave, being propagated in a cold plasma, whose concentration depends on a single coordinate x, has a peculiarity at the point where the tensor component of the dielectric penetrability goes to zero. The presence of this peculiarity leads to energy absorption of the wave, which does not disappear even in the absence of collisions. This absorption may be used for plasma heating. Experiments confirm the existence of this phenomenon. In this study the problem is solved for a moderately heated plasma, that is, with weak spatial dispersion being taken into account in order to estimate the practical possibilities of heating a plasma. It is shown that spatial dispersion leads to a situation where in place of energy absorption there takes place a transformation of the incident wave into a slow plasma wave. The energy carried by this plasma wave is equal to the energy absorbed in the cold plasma. The conditions under which the spatial dispersion can be considered as weak do not place any substantial limitations on plasma temperature in cases of practical interest. However, this approximation is not applicable at frequencies close to the cyclotron frequency or to the frequency of the second harmonic. (TTT)

23192 (IPP–6/72) KINETIC INTERACTION OF POSITIVE-ENERGY WAVES IN A PLASMA. Rebhan, E.; Wimmel, H. K. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec. 1968. 27p. Dep.

Summational invariants, conservation theorems, equilibrium spectra, and the H theorem associated with the kinetic equation for wave–wave interaction in a plasma are presented in their mutual relationship. If in some reference frame all waves have positive energies, then the system always goes to equilibrium. It follows from conservation theorems that the final equilibrium state depends on the initial conditions. Regular equilibria, with $N_k > 0$, may only occur as final states of time-varying solutions. For the "three-wave case," in which only separate wave triplets are coupled, the general solution of the initial-value problem is given, and it is shown that at sufficiently early times any time-dependent solution of the kinetic equation is either unphysical (some $N_k < 0$) or degenerate (some $N_k = 0$). (auth)

23193 (IPP–6/74) NONLINEAR QUASI-NEUTRAL ELECTROSTATIC PLASMA WAVES AND SHOCK WAVES. Tasso, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jan. 1969. 11p. Dep.

For the stationary one-dimensional Vlasov equation, quasi-neutrality is used instead of the Poisson equation. This allows one to obtain explicit solutions for the density as a function of the potential and to prove the positiveness of the trapped-particle distribution function in a potential interval. The usefulness of this method for oscillating waves and shock waves is obvious. (auth)

23194 TRANSFER OF MATERIAL BY A WAVE AND INSTABILITY OF WEAKLY IONIZED PLASMA ASSOCIATED WITH IT. Loladze, Ts. D.; Tsintsadze, N. L. (Inst. of Physics, Tbilisi, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 189-93(1969). (In Russian).

It is shown that traveling ion–acoustic waves may transfer the electron–ionic component in a weakly ionized plasma with a definite velocity. If this velocity is greater than the phase velocity of an ordinary sound wave, excitation of acoustic oscillation of plasma is observed. The presence of the material flux in plasma may lead also to the instability of tangential discontinuities between weakly ionized plasma and neutral gas. The conditions of excitation of acoustic oscillations are derived, as well as the criterion of instability of the interface of two media. (auth)

23195 FORMULATION OF PLASMA WAVE ECHOES AS AN INITIAL-VALUE PROBLEM. Nishikawa, Kyoji (Kyoto Univ.). Phys. Fluids, 12: 730-2(Mar. 1969).

Landau's solution for the linearized Vlasov equation describes a plasma wave echo for a certain class of initial perturbations. A criterion for the occurrence of an echo is examined, and new types of higher-order echoes are predicted. (auth)

23196 COLLISIONAL ABSORPTION AND EMISSION OF LONGITUDINAL WAVES IN A ONE-DIMENSIONAL PLASMA. Dawson, John M. (Princeton Univ., N. J.); Shanny, Ramy; Birmingham, Thomas J. Phys. Fluids, 12: 687-96(Mar. 1969).

Collisional absorption and emission of longitudinal waves in a one-species, one-dimensional plasma are investigated by numerical experiments. The theory of Birmingham, Dawson, and Kulsrud for longitudinal bremsstrahlung is extended to the one-dimensional case. The results of the numerical experiments are found to be in agreement with the theory. Low-frequency electric field fluctuations for long-wavelength modes are also found and are associated with the random motion of the particles. (auth)

23197 RESONANT ABSORPTION IN ZERO-TEMPERATURE NONUNIFORM PLASMA. Baldwin, D. E.; Ignat, D. W. (Yale Univ., New Haven). Phys. Fluids, 12: 697-701(Mar. 1969).

A process of absorption of energy by a cold nonuniform collisionless plasma from an externally driven electric field is described using a linearized theory. With the example of a cylindrically symmetric plasma, power is shown to be absorbed whenever the maximum plasma frequency exceeds the driving frequency. The admittance of the plasma as seen by an external circuit is developed and found to be sensitively dependent upon the equilibrium density distribution near the wall, suggesting the use of this phenomenon to examine electron sheath structure. Experimental results are presented which support the theoretical prediction. The occurrence of this absorption in the presence of a magnetic field and its effect upon the propagation of surface modes along a nonmagnetized plasma column are also indicated. (auth)

23198 FINITE-AMPLITUDE COLLISIONAL DRIFT WAVES. Stix, Thomas H. (Princeton Univ., N. J.). Phys. Fluids, 12: 627-39(Mar. 1969).

A calculation of mode–mode coupling for collisional drift waves demonstrates several inherently nonlinear phenomena, namely, amplitude saturation, harmonic generation, frequency shift, wave-associated transport across the magnetic field, and parametric excitation of subharmonics. There is qualitative agreement with published experiments; the introduction of some additional damping mechanism into the theory could narrow the broad quantitative discrepancy between theory and experiment. The analysis uses the nonlinear ion and electron fluid equations in which ion inertia, finite ion gyroradius, perpendicular ion viscosity, and resistivity terms have retained. No cross-B transport is produced by the large-amplitude steady-state oscillations in the absence of ion viscosity; nonambipolar transport in the pump-out direction appears when ion–ion collisions are introduced. A by-product of the calculations is a single nonlinear scalar wave equation for the collisional drift wave. Solutions to this equation show limit-cycle behavior, i.e., periodic but nonsinusoidal finite-amplitude oscillations which are stable (or unstable) against changes of oscillation amplitude. These nonlinear solutions are described by dispersion relations containing the oscillation amplitude as one of the parameters. (auth)

23199 PLASMA WAVE REGENERATION IN INHOMOGENEOUS MEDIA. **Berk, Herbert L.; Brook, David L. (Univ. of California, Livermore). Phys. Fluids, 12: 649-61(Mar. 1969).**

The one-dimensional problem of electrons confined in a quadratic potential is solved in the WKB approximation. The unique feature of the problem is that, since particle bounce time is independent of energy, resonant particles that normally cause Landau damping periodically interact with the wave and regenerate all phase information. Because of the efficiency of the regeneration mechanism, the dielectric properties governing the system change and give rise to "regenerative modes" associated with harmonics at twice the bounce frequency. The eigenvalues calculated in this WKB approximation are in agreement with previous numerical calculations. (auth)

23200 PARAMETRIC EXCITATION AND HIGHER-ORDER MODE COUPLING EFFECTS IN PLASMAS. **Goldman, Robert (Univ. of Maryland, College Park). Phys. Fluids, 12: 662-75 (Mar. 1969).**

Parametric excitation [wherein a Langmuir oscillation at (ω,k) simultaneously drives an ion–acoustic mode at (ω',k'), one sideband Langmuir oscillation at $(\omega - \omega', k - k')$, and possibly another at $(\omega + \omega', k + k')$] is considered. Steady-state solutions are found for these systems in various limits, taking into account contributions which are third order and higher in the mode fields. Connections with experiment are discussed. (auth)

23201 PROPAGATION OF HEAT IN PLASMA ALONG THE MAGNETIC FIELD (DISPLACEMENT WAVE). **Ivanov, A. A.; Kozorovitskii, L. L.; Rusanov, V. D. Dokl. Akad. Nauk SSSR, 184: 811-14(Feb. 1, 1969). (In Russian).**

A small part of a cylindrical plasma column was placed in a homogeneous magnetic field and heated ~10^{-7} sec by nonlinear oblique magnetoacoustic waves. The wave amplitude was measured by a magnetic probe and the plasma pressure by a diamagnetic transducer encompassing the chamber. The experimental data were interpreted by means of nonlinear solutions, which were called the substitution wave. A mathematical analysis was made of the heat propagation as a function of hot particle distribution. The results showed that the substitution wave interpretation produced satisfactory results. (R.V.J.)

23202 SCATTERING OF ELECTROMAGNETIC WAVES ON HYDRODYNAMIC PULSATIONS OF TURBULENT PLASMA. **Makhan'kov, V. G.; Sakhokiya, D. M.; Tsytovich, V. N. (Tbilisi State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 141-4(1969). (In Russian).**

Scattering of high-frequency electromagnetic waves on small-scale turbulent plasma in electromagnetic fields was studied considering in particular, interactions of high-frequency waves with specific oscillations existing in the region of frequent collisions. Data obtained were generalized for the interactions of transverse waves with longitudinal and transverse with transverse. The problem of transverse wave scattering on low-frequency hydrodynamic turbulence was analyzed. Formulas obtained can be applied in astrophysics and in isothermal plasma studies. (R.V.J.)

23203 NONLINEAR INTERACTION OF INTENSIVE PLASMA WAVES. **Tsytovich, V. N.; Chikhachev, A. S. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 26-35(1969). (In Russian).**

It is shown that in many cases of intensive wave interaction the change of particle distribution must be taken into account. The wave interaction inside the packets may be neglected if the waves are strong enough. The interaction between strong packets does not change. It is also shown that the interaction between strong and weak waves does not change due to the effect considered if the value and the direction of a weak wave pulse remarkably differ from those of a strong wave pulse. (auth)

23204 NUMERICAL SOLUTIONS OF ELECTROMAGNETIC WAVES IN INHOMOGENEOUS MAGNETOPLASMA SLABS. **Kalluri, Dikshitulu K. Lawrence, Kan., Univ. of Kansas, 1968. 279p.**

Thesis.

The numerical solution for the reflection, transmission, and absorption coefficients is derived for the case of oblique incidence of an arbitrary polarized free space plane wave on a warm magnetoplasma slab with arbitrarily directed static magnetic field. Both homogeneous and inhomogeneous plasma slabs are considered. From the general solution for the homogeneous case, several degenerate solutions are obtained for the particular cases. For parallel polarization and temperature magneto-plasma slab, it is found that 180° rotation of the static magnetic field in the plane of incidence does not change the free space fields. An analytical solution is given for the case when the static magnetic field is perpendicular to the plane of incidence. The effect of variation of the wave frequency, the magnitude and orientation of the static magnetic field, angle of incidence, slab width and electron temperature are studied. Numerical results are presented in terms of the parameters normalized with respect to the plasma frequency. The solution for waves in inhomogeneous warm magnetoplasma slab for oblique incidence is obtained by two methods. In the sub-slab method, the plasma slab is horizontally stratified. In each stratified layer, called sub-slab, the particle density is assumed constant and is treated as a homogeneous slab. The full wave solution is obtained by developing the first order coupled differential equations in the variables E_x, E_y, H_x, H_y, u_z and p, where the electron density is inhomogeneous with respect to the z-coordinate normal to the plasma slab and the plasma slab is infinite in extent in the x and y directions. The variable p is eliminated and a second order differential equation in u_z is obtained. The system of differential equations with the boundary conditions that u_z is zero at either of the plasma free space interfaces is solved by the "shooting method." Adams–Moulton predictor-corrector method is used for the numerical integration of the differential equations. Numerical results are obtained for linear, parabolic and exponential electron density profiles and are presented in terms of parameters normalized with respect to the plasma frequency at the middle of the slab. The effect of ion motion on the waves is also examined. (Disser. Abstr.)

23205 BEAM MIXING OF PLASMAS UNDER THE INFLUENCE OF A MAGNETIC FIELD. **Schilling, Heinz (Institut fuer Optik und Spektroskopie, Berlin). Beitr. Plasmaphys., 8: 455-67(1968). (In German).**

In the reflection of polarized electromagnetic waves on the magnetoactive plasma, the beam mixing depends, just as in isotropic plasma, preponderantly on the ratio between the sending frequency ω and the collision frequency v_{eff}. If the cyclotron frequency ω_c is small with respect to the sending frequency, the effect of the magnetic field is strongest for the beam whose incident field cuts the boundary field parallel to the external field. There are two mixing maxima that are separated only when the magnetic field strength is very great and when sending and plasma frequencies are not too strongly deviant from each other. If the cyclotron frequency is large with respect to the sending frequency, large values of the beam mixing occur only at the boundary angle of the extraordinary beam. Site, height, and width of the mixing maximum depend as in the case $\omega_c \ll \omega$ on the azimuth of the incident field with respect to the principal section of the separation plane and on the field direction; they are independent of the strength of the external field. (tr-auth)

23206 REFLECTION OF A PLANE TRANSIENT ELECTROMAGNETIC WAVE FROM A COLD LOSSLESS PLASMA SLAB. **Wait, James R. (Univ. of Colorado, Boulder). Radio Sci., 4: 401-5(Apr. 1969).**

Reflection of a plane transient electromagnetic wave from a plasma half-space and a plasma slab is considered. The plasma is assumed to be cold and collisions are neglected. Under these assumptions, the Laplace transforms may be inverted exactly, yielding a solution in the form of Bessel function series. The numerical results, for the waveform of the reflected field, exhibit features that are easily related to the plasma frequency of the slab and its thickness. (auth)

23207 QUASI-FLUID ELECTRON FLUTE MODES IN COLLISIONLESS PLASMAS. **Coppi, B. (Inst. for Advanced Study, Princeton, N. J. Princeton Univ., N. J.). Phys. Lett., 28A: 685-6(Feb. 24, 1969).**

Collisionless plasmas, having electron temperature larger than or of the order of the ion temperature and confined in a periodically varying magnetic configuration, are shown to be subject to macroscopically unstable flute modes with a growth rate larger than the average ion excursion frequency. (auth)

23208 ELECTROMAGNETIC MODE IN COUNTERSTREAMING PLASMAS IN A MAGNETIC FIELD. **Lee, Kai Fong (National Center for Atmospheric Research, Boulder, Colo.). Phys. Rev., 181: 447-52(May 5, 1969).**

Electromagnetic waves propagating across an external magnetic field are investigated for a system composed of two identical counterstreaming electronic plasmas. Using the cold-plasma equations, it is found that the extraordinary wave is unaffected by relative streaming, while the ordinary wave is modified. The modified ordinary wave remains linearly polarized, but becomes dependent on the magnetic field. It has two propagation bands, one of which can be below the plasma frequency. This mode becomes unstable if the ratio of plasma frequency to electron gyrofrequency exceeds one-half the ratio of light velocity to relative streaming velocity. Brief discussion is given on the general case of nonidentical streams. (auth)

23209 THERMAL STABILIZATION OF THE MODIFIED ORDINARY WAVE. Lee, Kai Fong (National Center for Atmospheric Research, Boulder, Colo.). Phys. Rev., 181: 453-6(May 5, 1969).

Thermal stabilization of the modified ordinary (MO) wave propagating across an external magnetic field in a two-stream electron plasma is studied. It is found that temperature (1) increases the threshold of the relative streaming velocity below which the wave is stable, (2) imposes an upper limit on the spectrum of unstable wave numbers, and (3) reduces the growth rate. Discussion is given on the physical mechanism of the instability. (auth)

23210 THE NONLINEAR INTERACTION OF A STEADY-STATE CIRCULARLY POLARIZED ELECTROMAGNETIC WAVE WITH A COLD PLASMA IN A CONSTANT LONGITUDINAL MAGNETIC FIELD. Luenow, W. (New Mexico State Univ., Las Cruces). Plasma Phys., 10: 973-86(Nov. 1968).

The strictly relativistic, nonlinear solution describing the interaction of a stationary, circularly polarized electromagnetic wave with a cold plasma in a constant longitudinal magnetic field is derived. Apart from the a priori restriction that the plasma in the wave–plasma–magnetic field system under consideration be cold, no other restriction is imposed on the range of validity of the solution, which is thus valid for any values of the parameters. The solution allows exact study of the resonance and cut-off behavior of wave–plasma–magnetic field systems of the kind described. The nonlinear relations between the wave, plasma and field parameters can be solved numerically without approximations. Owing to the complicated nature of the equations a special case is treated which conveys some idea of the general relationships. (auth) (UK)

23211 WEAK TURBULENCE THEORY OF VELOCITY SPACE DIFFUSION IN A MAGNETIC FIELD. Manheimer, Wallace M. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 12: 901-14(Apr. 1969).

The particle–wave interaction to arbitrary order in perturbation theory is investigated for a weakly turbulent plasma in the presence of a uniform magnetic field. It is found that to every order in perturbation theory, the ensemble average distribution function obeys a diffusion equation in $\nu_{\perp}\nu_{z}$ space. By conservation of energy and momentum between waves and particles, the growth or damping rate to any order may be determined. The damping rate for nonlinear cyclotron damping, the particle energization rate from very low-frequency turbulence, and the growth rate for a nonlinear instability are calculated. (auth)

23212 COLLISIONAL DAMPING OF PLASMA OSCILLATIONS. McBride, John B. (Dartmouth Coll., Hanover, N. H.). Phys. Fluids, 12: 844-9(Apr. 1969).

The linearized kinetic equation with a uniform external magnetic field is solved for the perturbed electron distribution function. The collision term is assumed small, but otherwise is arbitrary. Using this solution, the general dispersion relation for electron waves is derived. One mode, longitudinal plasma oscillations along the magnetic field, is worked out in detail with the Landau (Fokker–Planck) collision term. An equivalent moment equation approach is also used, and it is found that the divergence of the heat flow tensor must be retained in the third-moment equation in order to obtain the correct first-order thermal correction to the damping rate. Both methods yield $\omega_I = -\frac{1}{2}\omega_p(2/\pi)^{1/2}(\ln\Lambda/\Lambda)[1-(2-4\sqrt{2}/5)k^2\lambda_D^2]$. This damping rate decreases as k increases, and disagrees with earlier results based on the Landau equation. It appears that these previous treatments have not included the complete thermal correction. (auth)

23213 COLLISIONAL DAMPING OF TRANSVERSE WAVES IN A PLASMA. McBride, John B. (Dartmouth Coll., Hanover, N. H.). Phys. Fluids, 12: 850-2(Apr. 1969).

The Landau (Fokker–Planck) equation is used to calculate the temporal damping rate for the small amplitude, transverse electromagnetic mode (linearly polarized) for (a) no external fields, and (b) a uniform magnetic field. In (a) the damping rate is found by using a solution to the kinetic equation to evaluate the electron current. This damping may be recovered from the zero field limit of a previous result of Buti for the right circularly polarized mode after a correction is made in that result. In (b) a moment equation approach is used, and the heat flow tensor components are evaluated using a solution to the kinetic equation. The damping in (b) depends on the magnetic field only in the thermal correction, and reduces to that in (a) when magnetic effects are negligible. (auth)

23214 SPATIAL ION-WAVE ECHOES. Ikezi, H. (Nagoya Univ., Japan); Takahashi, N.; Nishikawa, K. Phys. Fluids, 12: 853-65(Apr. 1969).

Theory and experiments of spatial ion-wave echoes are reported. In the collisionless approximation, the calculated line shape of the second-order echo is found to be a universal function of $\Delta x/\delta$, the distance from the expected position of the echo divided by the Landau damping length of the ion-wave constituting the echo. Higher-order echoes predicted by Gould are observed up to the fourth order with respect to the external fields at the predicted positions with the predicted dependence of their amplitude on the amplitude of the primary waves. In addition, new types of higher-order echoes which result from the electric fields of other echoes are predicted and observed. Measurements of the peak amplitude of the second-order echo as a function of the separation l between the two exciters indicate that the memory of the past excitation retained in the distribution function damps exponentially with the attenuation length proportional to the wavelength of the excited wave. The effect of ion–neutral collisions on the peak amplitude is studied and explained fairly well by a simple relaxation time model, but the predicted effect of ion–ion collisions based on a Fokker–Planck-type equation is not observed within the separation length l of 20 cm and the plasma density of $10^{10}/\mathrm{cm}^3$. (auth)

23215 ELECTROMAGNETIC ECHOES IN COLLISIONLESS PLASMAS. Wong, Alfred Y. (Univ. of California, Los Angeles). Phys. Fluids, 12: 866-8(Apr. 1969).

A new process for generating electromagnetic echoes is proposed which depends upon the velocity distribution and the magnetic interaction enhanced by plasma collective effects. (auth)

23216 THOMSON SCATTER MEASUREMENTS OF MAGNETIC FIELD EFFECTS ON THE LANDAU DAMPING AND EXCITATION OF PLASMA WAVES. Fremouw, E. J. (Stanford Research Inst., Menlo Park, Calif.); Petriceks, J.; Perkins, F. W. Phys. Fluids, 12: 869-74(Apr. 1969).

Radar observations of Thomson scatter from the nonthermal, steady-state level of plasma waves in the ionosphere are used to test the predictions of kinetic theory with regard to how the nonthermal level of the waves depends on the angle between the wave vector and the magnetic field. Nonthermal effects are produced by a high-energy, photoelectron tail on the otherwise Maxwellian electron velocity distribution. Observations were made at several angles varying from nearly parallel to nearly perpendicular (where cyclotron resonance effects play a major role) to the magnetic field. The results are in consistent agreement with kinetic theory. (auth)

23217 HARMONIC GENERATION IN IONIZED NITROGEN. Varnum, William S.; Desloge, Edward A. (Florida State Univ., Tallahassee). Phys. Fluids, 12: 816-21(Apr. 1969).

The effect of collisions on the generation of harmonics in ionized molecular nitrogen subjected to an alternating electric field is examined theoretically. The electron distribution function is approximated by a function containing four undetermined parameters. The Boltzmann transport equation is then used to obtain a set of kinetic equations for these parameters. The kinetic equations are used to determine the harmonic generation in a uniform ionized gas subjected to a homogeneous alternating electric field. The nonlinearity which must be present in the kinetic equations in order to produce harmonics is assumed to arise from velocity-dependent electron–molecule collision frequencies. It is shown that the principal harmonic generated is the third harmonic. An expression for the third harmonic current density is obtained. Available elastic and inelastic cross-section data are used to apply the general result to the case of ionized nitrogen, and the results are compared with two related microwave discharge experiments. (auth)

23218 MICROWAVE-INDUCED PLASMA SHIELD PROPAGATION IN RARE GASES. Bethke, George W.; Ruess, Allen D. (General Electric Co., King of Prussia, Pa.). Phys. Fluids, 12: 822-35(Apr. 1969).

It has been observed that microwave irradiation of localized weak ionization in heavy rare gases can cause an ionization wave ("plasma shield") to form and propagate toward the rf source.

This ionization wave is preceded by an electron precursor, with the electron density at the ionization wave front increasing very rapidly to a maximum followed by a relatively slow plasma decay. At rf power levels well below normal breakdown, the ionization wave will form and then propagate at velocities from about 2 × 10^3 cm/sec to 1 × 10^7 cm/sec. Discontinuous changes of ionization wave velocities with changes in rf power and gas pressure indicate the existence of three different velocity-controlling mechanisms in the gas pressure and rf power ranges investigated. These mechanisms for ionization wave formation and propagation have been investigated in xenon, krypton, and argon gases, and are discussed. (auth)

23219 GENERATION OF TRANSVERSE WAVES BY NONLINEAR WAVE–WAVE INTERACTION. Krishan, S.; Selim, A. A. (Univ. of Alberta, Edmonton). Plasma Phys., 10: 931-7(Oct. 1968).

The excitation of transverse plasma modes by nonlinear interaction is analyzed by forming the Hamiltonian in terms of creation and annihilation operators for the quasi particles (waves). The lowest-order interaction occurs at order three of creation and annihilation operators. To this order the Hamiltonian contains the effects due to the processes of (a) two longitudinal waves interacting to generate one transverse wave, (b) one longitudinal wave interacting with one transverse wave yielding one transverse wave, and (c) two transverse waves colliding to produce one longitudinal wave. The relaxation time for the transfer of energy from the longitudinal modes to transverse modes is calculated for an isotropic, homogeneous, collisionless electron plasma. (auth) (UK)

23220 NONLINEAR INTERACTION BETWEEN ELECTROACOUSTIC AND TEM WAVES AT MICROWAVE FREQUENCIES. O'Brien, B. B. Jr. (Institut fuer Plasmaphysik, Munich). Plasma Phys., 10: 951-61(Oct. 1968).

Measurements of mixing (nonlinear interaction) of two low-level microwave signals in an isotropic positive column are described. One signal (650 MHz) excited a propagating electroacoustic wave. The other signal (1150 MHz), propagating along a "TEM" line, interacted with the plasma wave whereby signals with the sum and difference frequencies were produced (and observed). The amplitudes of the scattered signals were in reasonable agreement with the values predicted by a simple theory involving an "equivalent" dielectric constant. (auth) (UK)

23221 ABSORPTION OF LIGHT IN THE REFLECTING SKIN OF A COLLISIONLESS PLASMA. Caruso, A. (EURATOM–CNEN, Rome). Plasma Phys., 10: 963-5(Oct. 1968).

It is shown that the reflecting layer of a collisonless plasma behaves as a resistive system if there is a point where the plasma frequency is twice the frequency of the reflected light; the absorption of energy as well as the lifetime of the layer are calculated. (auth) (UK)

23222 DISPERSION OF ELECTRON PLASMA WAVES. Barrett, P. J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.); Jones, H. G.; Franklin, R. N. Plasma Phys., 10: 911-18 (Oct. 1968).

The propagation of electron plasma waves along a cylindrical plasma column in a strong magnetic field was studied both theoretically and experimentally. The dispersion equation for such waves was solved numerically where the plasma density profile was assumed to be either uniform or parabolic and the electron energy distribution Maxwellian. Dispersion curves were computed for the $m = 0$ azimuthal mode and compared with experimental points obtained from a thermally ionized plasma in a strong magnetic field over the range of electron density 10^7 to 10^{10} cm^{-3}. (auth) (UK)

23223 DISPERSION RELATION AND THE ENERGY TRANSFER OF A WAVE PACKET IN INHOMOGENEOUS ANISOTROPIC MEDIA. Jungwirth, K. (Inst. of Plasma Physics, Prague). Plasma Phys., 10: 919-26(Oct. 1968).

The dispersion relation of a quasi-monochromatic wave in an inhomogeneous anisotropic medium is found without imposing any restrictions upon the ratio between the potential and the non-potential part of the electric field of the wave. For waves with slowly varying amplitudes, expressions for the energy density W, energy flux density S and energy dissipation Γ are derived, which can be used even if the gradient effects are not negligible. The physical mechanisms underlying the gradient effects are demonstrated by the model of a plasma in a strong external magnetic field. (auth) (UK)

23224 ION WAVES IN A PARTIALLY IONIZED GAS IN AN EXTERNAL ELECTRIC FIELD. Aubrecht, L. (Technical Univ., Prague). Czech. J. Phys., 18: 1602-9(1968).

The propagation of longitudinal acoustic waves in the ion gas in an external electric field is studied theoretically. The results are compared with properties of waves in space without the external field. The phase velocities, damping factors, and the influence of parameters of the gas on the properties of ion waves are discussed. (auth)

Shielding

Refer also to abstracts 22002, 22078, 23579, 23580, 23843, and 23887.

23225 (ISS–68/26) INTRODUCTION TO RADIATION PHYSICS. CHAPTER IX. PART I. Amaldi, U. Jr. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Sept. 6, 1968. 92p. (In Italian). Dep.

The first part of this issue is devoted to the three main phenomena through which x and γ quanta interact with matter, photoelectric effect, Compton effect and pair production. After a presentation of the energy behavior of the cross sections and of the energy spectra of the associated corpuscular radiation, attenuation coefficients are introduced and attenuation measurements are discussed. (auth)

23226 (ORNL-TM-2462) CALCULATION OF THE NEUTRON AND PROTON SPECTRA FROM THICK TARGETS BOMBARDED BY 450-MeV PROTONS AND COMPARISON WITH EXPERIMENT. Alsmiller, R. G. Jr.; Wachter, J. W.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Jan. 6, 1969. 29p. Dep. CFSTI.

Nucleon–meson cascade calculations were carried out for 450-MeV protons incident on a variety of thick targets. The energy spectra of emitted neutrons and protons at specific angles are compared with experimental measurements. (auth)

23227 (ORNL-tr-1192) ATTENUATION OF HIGH ENERGY μ-MESONS IN SHIELDING MATERIAL. Sychev, B. S.; Cherevatenko, A. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn., from report JINR-P-2354. 6p. Dep. CFSTI.

An abstract of the original Russian report appeared in NSA 20: 3238. (L.M.T.)

23228 HIGH-ENERGY (<400-MeV) NEUTRON TRANSPORT USING THE METHOD OF DISCRETE ORDINATES. Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.); Mynatt, F. R.; Barish, J.; Engle, W. W. Jr. Nucl. Sci. Eng., 36: 251-5(May 1969).

In order to test the validity of the discrete ordinates approach at higher energies, calculations were made for the case of 400-MeV neutrons normally incident on a semi-infinite slab of aluminum oxide using the discrete ordinates ANISN code and the Monte Carlo NTC code, which treats both protons and neutrons. Calculations were also made with both codes for the case of 400-MeV neutrons isotropically incident on a semi-infinite slab of aluminum and hydrogen. Reasonable agreement was obtained for the neutron flux per unit energy; the differences between the ANISN and NTC results are mainly attributable to the neglect of the proton contribution in the ANISN code. (D.C.W.)

23229 PROBLEME DES BAUTECHNISCHEN STRAHLENSCHUTZES. III. VORTRAEGE GEHALTEN AUF EINER SITZUNG DES FACHAUSSCHUSSES III STRAHLENSCHUTZ AM 28./29. NOVEMBER 1967 IN ERLANGEN. (Problems of Structural Engineering for Radiation Protection. III. Lectures Presented at a Meeting of the Third Professional Committee on Radiation Protection, November 28–29, 1967). Schultz, H.; Bagge, E.; Boehnecke, G. (eds.). Berichte der Studiengesellschaft zur Foerderung der Kernenergieverwertung in Schiffbau und Schiffahrt e.V., Hamburg, No. 15. Munich, Verlag Karl Thiemig KG, 1968. 247p. DM 24.80. (CONF-671137).

Separate abstracts were prepared for 12 of the 13 lectures presented at the subject meeting. Text of the lecture "Results of Radiation Field Measurements of the Gundremmingen Nuclear Power Plant" by A. Palavicino was not included in this compilation. (J.S.R.)

For abstracts of individual papers see: 23230–23235, 23843, 23887, and 23898–23901.

23230 PRACTICAL USE OF TRANSMISSION AND REFLECTION MATRICES. Maute, A. H. (Univ., Stuttgart). pp 1-13 of Probleme des Bautechnischen Strahlenschutzes. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).

From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

The application of transmission and reflection matrices to shielding problems is discussed. The matrix elements are approximated through analytical expressions as functions of the layer thickness. The transmission method was tested on a special case with 10 energy groups between 0.5 and 3 MeV. Thick layers must be calculated by a combination of the transmission and reflection matrices of thin layers. Penetrating and reflecting fluxes were calculated, and the results were tabulated to show the utility of the transmission and reflection matrices. The computer programs devised were briefly described. (J.S.R.)

23231 COMPARISON CALCULATIONS BETWEEN P_L AND S_N APPROXIMATIONS AND THE MONTE CARLO METHOD. Hehn, G. (Univ., Stuttgart). pp 15-28 of PROBLEME DES BAUTECHNISCHEN STRAHLENSCHUTZES. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).
From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

The convergence of the P_L and the S_N approximations were studied on shielding examples. It was shown that the P_L approximation undervalues the beam transport principally by thick material layers, but the method converges well. The next higher development step leads to significant reduction of the error. This is not the case in the S_N approximation; in the lower approximation there is an undervaluation and in the higher approximation an overvaluation of the flux. The error can increase when one passes to a higher development step. The convergence is poorer than in the P_L approximation. For control calculations the P_7 or S_{16} approximations should be used. The group data should be available for shielding purposes in the P_5 approximation. Monte Carlo and P_L calculations give good agreement up to 12 mean free path lengths. For higher-layer thicknesses the Monte Carlo method leads to smaller flux values. For control calculations it is not therefore suitable. However, site-dependent cross bucklings can be determined by the Monte Carlo method. These data can be given in a one-dimensional P_L program and treated in the first approximation of two-dimensional problems by transport theory. (tr-auth)

23232 DIFFUSION GROUP CONSTANTS DERIVED FROM RESULTS OF TRANSPORT CALCULATIONS. Fiebig, R. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). pp 29-59 of Probleme des Bautechnischen Strahlenschutzes. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).
From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

The transport calculations were evaluated in order to determine the effect of the assumptions of the diffusion calculation on the group constants. The calculations showed that the selected diffusion constants were higher than the P1 diffusion constants and show transients at the layer boundary. Group removal cross sections show in heavy materials the ratio of flux to the upper group boundary. In order to avoid material and site dependencies, group boundaries must not lie in the extreme value of the cross section. The most difficult problem is the selection of the correct spectrum for the determination of group cross sections. If the space-determined constants are available for a given arrangement, the diffusion calculation results are good. This means that the transients do not play a large role. (tr-auth)

23233 IMPROVEMENT OF THE REMOVAL-DIFFUSION THEORY. Vossebrecker, H. (INTERATOM, Bensberg, Ger.). pp 61-72 of Probleme des Bautechnischen Strahlenschutzes. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).
From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

A study was made to improve the removal diffusion theory by consideration of some previously neglected effects. The influence of these effects leads partially to larger and partially to smaller flux oscillations. The data are not sufficient yet to determine if these influences in toto give larger or smaller effective cross sections. (tr-auth)

23234 USE OF REMOVAL-DIFFUSION CONCEPTS IN IRON-WATER ARRANGEMENTS. Fiebig, R. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH., Hamburg). pp 127-32 of Probleme des Bautechnischen Strahlenschutzes. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).
From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

The removal cross sections of H_2O were compared with the diffusion lengths of the diffusion groups. The comparison showed that in sufficiently heavy water layers the propagation of neutrons is determined not alone through the removal groups but also by the first diffusion group. The calculation of this effect was made on an iron/water arrangement. The results showed that the removal-diffusion method is still the same semi-empirical description of the neutron propagation. (J.S.R.)

23235 CALCULATION OF THE PROPAGATION OF GAMMA RADIATION IN AIR CHANNELS WITH SEVERAL DEFLECTIONS. Futtermenger, W. (Technische Univ., Hanover). pp 133-55 of Probleme des Bautechnischen Strahlenschutzes. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).
From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

An approximation method was developed for the calculation of the propagation of γ radiation in air channels with several deflections. The method takes into consideration the geometry of the deflection and the integral energy flux density albedo factors. Results of the Monte Carlo calculation are tabulated. (J.S.R.)

23236 GAMMA-RAY DOSES FOR ALL POINTS IN SPHERES AND CYLINDERS WITH UNIFORMLY DISTRIBUTED SOURCES. Hubbard, L. B.; Williamson, F. S. (Argonne National Lab., Ill.). Phys. Med. Biol., 14: 255-67(Apr. 1969).

A method is given for the calculation of the doses for all points in right circular cylinders containing uniformly distributed γ-ray sources either with or without absorption. This approximate method utilizes parameters calculated by numerical techniques. Parameters applicable to a wide range of absorption coefficients and cylinder dimensions are presented. This method, which involves only simple arithmetic, should yield doses correct to within a few percent for cylinders whose dimensions are less than a photon mean free path. (auth) (UK)

23237 THE INVESTIGATION OF GAMMA-RAY ATTENUATION IN TAIWAN'S BUILDING MATERIALS. Huang, C. Y.; Yung, S. H. (Atomic Energy Council, Taipei, Taiwan). Ho Tsu K'o Hsueh, 6: 69-73(Oct. 1968). (In Chinese).

Cobalt-60, cesium-137, and radium-226 were used as the gamma sources for studying the gamma-ray attenuation in Taiwan's building materials such as lead, iron, concrete, red brick, glass, and soil. Both narrow- and broad-beam studies were made. The buildup factor and the scattered beam were also investigated in part of the experiment. (auth)

Solid-State Physics

Refer also to abstracts 21938, 22063, 23048, 23674, 23688, 23689, and 23746.

23238 (AERE-Trans-1102) METHOD OF MEASURING THERMAL DIFFUSIVITY BY STEP-FUNCTION HEATING. Kobayashi, K.; Kumada, T. Translated by S. G. Brickley for Atomic Energy Research Establishment, Harwell, Eng., from Nippon Genshiryoku Gakkaishi, 9: 58-64(1967). 16p. Dep. CFSTI. UK 3s.

A transient method for quickly measuring the thermal diffusivity of a small solid disk (15-mm diameter, 2 ~ 10 mm thickness) was developed. The disk is placed in vacuum and heated from the front by thermal radiation whose intensity is varied in a step function. The resulting change in temperature on the rear face is measured by thermocouple and recorded by oscillograph, and the thermal diffusivity is calculated from the data obtained. Since each measurement requires only a few seconds, the method is far less stringent regarding stability of ambient temperature as compared to steady methods, while saving time without sacrificing accuracy. The measured values at temperatures ranging from 25 ~ 700°C on lead, copper, and nickel of high purity were within ±5% of values from previously reported measurements. Values for thermal diffusivity of UO_2 pellets were also determined at temperatures ranging 25 ~ 800°C. The error was not more than ±5%. The method was tested experimentally in the temperature range between 25 and 800°C, but analysis suggests that more accurate measurements of thermal diffusivity can be made by this technique at higher temperatures. (auth) (UK)

23239 (CEA-R-3722) AUTOMATIC MAGNETIC SUSCEPTIBILITY MEASUREMENTS BETWEEN 4^0K AND 1200^0K. Raphael, Georges (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan. 1969. 36p. (In French). Dep.

Detailed description is given of a Faraday magnetic susceptibility balance which operates from 4°K to 1200°K. Some preliminary results on UO_2, PuO_2, platinum, and titanium illustrate the precision and the sensitivity of the measurements. The apparatus was designed for measurements on the plutonium compounds which present severe health hazards. (auth)

23240 (COO-1629-13) THERMAL MEASUREMENTS ON SOLIDS BELOW 1^0K. Progress Report No. 3. Weinstock, Harold

(Illinois Inst. of Tech., Chicago. Dept. of Physics). Feb. 1969. Contract AT(11-1)-1629. 12p. Dep. CFSTI.

COBALT CHLORIDES—complexes with thiourea, thermal conductivity in magnetic field
GAMMA RADIATION—effects on pure potassium chloride single crystals, thermal conductivity studies of defects produced in
MAGNETIC FIELDS—effects on thermal conductivity of cobalt chloride thiourea
MAGNETIC PROBES—calibration of indium–arsenide Hall
POTASSIUM CHLORIDES—radioinduced defects in pure single crystals of, thermal conductivity studies of gamma
UREA, THIO-—complexes with cobalt chloride, thermal conductivity in magnetic field (D.L.C.)

23241 (GA-8675) CENTRAL FORCE LATTICE DYNAMICAL MODEL FOR URANIUM CARBIDE. Slaggie, E. L. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 23, 1968. Contract AT(04-3)-167. 19p. Dep. CFSTI.

In order to describe the thermal neutron scattering from UC, a central-force lattice dynamical model similar to that for ZrH_2 was calculated. The force constants could not be determined exactly, but the calculated frequency distribution is in qualitative accord with the limited neutron data and the fits to specific heat data are good. It is concluded that the central-force model is an improvement over the phenomenological Gaussian–Debye model. (D.L.C.)

23242 (ORO-2755-24) SURFACE PROPERTIES OF MAGNETIC MATERIALS. Progress Report No. 9, March 1, 1968–February 28, 1969. Scheibner, E. J. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(40-1)-2755. 152p. Dep. CFSTI.

AUGER ELECTRONS—distribution in solids, equation for
—transition densities, methods for analysis of data for
COPPER—electron characteristic energy losses in (100) surface of
—optical properties of (100) surface of single-crystal
ELECTRON-DIFFRACTION ANALYSIS—techniques development for low-energy, for studying single-crystal surfaces and inelastic scattering processes
ELECTRONS—energy losses in copper and nickel, characteristic
GRAPHITE—Auger spectra and transition densities of
NICKEL—electron characteristic energy losses in (100) surface of
—optical properties of (100) surface of single-crystal
PLASMA, SOLID-STATE—oscillations in metals, theory of collective
SILICON—Auger transition densities of (111) surface of (D.L.C.)

23243 METHOD OF ANALYSIS OF THIN SURFACE LAYERS BY THE MOESSBAUER EFFECT. Bonchev, Zw.; Jordanov, A.; Minkova, A. (Univ. of Sofia). Nucl. Instrum. Methods, 70: 36-40(Apr. 1, 1969).

A method for investigation of the surface layers composition and structure is described. The conversion electrons emitted after recoilless absorption of gamma-rays are used. The conversion electron energy depends on the thickness of the layer the electrons pass across. That is why the obtained Moessbauer spectra with electrons coming from different depths characterize the layers these electrons have been formed in. The conversion electrons are focused by a small iron-free beta spectrometer with corrected field shape. The investigations are made using the nuclide ^{119}Sn. The possibilities of the method are illustrated with a tin surface treated over bromine vapors. The Moessbauer spectra with electrons from three different depths are shown. The spectra of a tin surface treated over fumic nitric acid are also investigated. For the SnO_2-layer, differs the observed relation between the experimental effect, 8%, and the electron energy at room temperature and at liquid nitrogen temperature greatly. (auth)

23244 DEFECTS CREATED BY ELECTRON BOMBARDMENT IN SOLIDS. Cordier, Alain; Degeilh, Andre (CNRS, Toulouse). J. Microscop., 7: 465-90(1968). (In French).

Methods for study of defects induced by particle bombardment of solids are reviewed. Experiments for determining electrical, mechanical, and optical properties of the sample may be used to explain the behavior of faults produced by electron bombardment. More recently, electron microscopy has been introduced. A review of low-temperature irradiation studies and stages of recovery of the crystal on heating are given. Knowledge of reorientation of certain defects and the type and location of these defects is possible through the use of transmission electron microscopy. Only 8 examples of the use of this method were found in the literature, and the fragmentary nature of the use of this means of analysis indicates a need for further application of the technique. Studies of the formation and clustering of Frenkel defects are in progress. (BBB)

23245 POSSIBLE DISTORTIONS AND SHIFTS OF SIGNALS OF NUCLEAR MAGNETIC RESONANCE ABSORPTION AT THE OVERHAUSER EFFECT. Alekseev, B. F.; Sobotkovskii, B. E. (Leningrad Electrotechnical Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 236-42(1969). (In Russian).

It is shown that the signal of NMR absorption as a function of the magnetic field is distorted and may be shifted at the Overhauser effect. The shift of the NMR absorption line depends on the shift of the saturation frequency relative to the resonance frequency of the field in which NMR is observed. The distortions and the shift are increased as the ratio of the widths of the unsaturated EPR line and the NMR line and the degree of EPR saturation are decreased. The method is proposed to calculate the necessary frequency stability of EPR saturation for eliminating the given shift. (auth)

23246 ESR STUDIES OF PARAMAGNETIC CENTRES IN IRRADIATED $Li_2SO_4.H_2O$. Hariharan, N.; Sobhanadri, J. (Indian Inst. of Tech., Madras). J. Phys. Chem. Solids, 30: 778-81(Mar. 1969).

Single crystals of $Li_2SO_4 \cdot H_2O$ grown from aqueous solution at room temperature and at 60°C were exposed to uv and x radiation and ESR spectra of these crystals were obtained at room and liquid-nitrogen temperatures. X-ray-diffraction studies showed that the crystals grown at different temperature had the same monoclinic unit cell with identical dimensions. The ESR spectra of the two crystals after irradiation were, however, markedly different. The results obtained are compared with those of Wigen and Cowen (1960) and Aseltine and Kim (1967). (UK)

23247 CHANNELING OF DEUTERONS IN QUARTZ. Abel, Francois; Amsel, Georges; Bruneaux, Michel; d'Artemare, Emmanuel (Ecole Normale Superieure, Paris). J. Phys. Chem. Solids., 30: 687-703(Mar. 1969). (In French).

The channeling of deuterons in quartz was studied in order to separate the effects of the oxygen and silicon sublattices. The elastic scattering and the reaction $^{16}O(d,p)^{17}O^*$ were observed at 900 keV. An automatic angular scanning device was used, and particular care was taken to reduce the effects on the crystal of the radiation damage induced by the beam. The extinction ratio of the yields was measured as a function of the beam angle with the c axis and of the depth in the crystal. It was found near the surface to be 96.8% for silicon and 89% for oxygen. The corresponding widths at half minimum were 64′ and 36′. These experiments show that, in addition to elastic scattering, nuclear reactions should also be observed; this is especially easy at low energies with deuterons. It appears that the silicon strings tend to narrow the extinction curve and to increase the minimum yield associated with the oxygen strings. (auth) (UK)

23248 CYCLOTRON RESONANCE IN NATURAL CRYSTALS OF GRAPHITE. Bhattacharya, R. (Indian Association for the Cultivation of Science, Calcutta). Indian J. Phys., 42: 384-5 (June 1968).

A brief interpretation of the observed cyclotron resonance of natural crystals of graphite is proposed, taking account of misalignments that affect bulk properties. This can possibly account for the apparent mass spread of carriers envisaged by Nozieres (Phys. Rev., 109: 1510(1958)), without having to assume a complexity in the band structure. (L.M.T.)

23249 DETERMINATION OF THE POLARIZATION OF BRAGG-REFLECTED GAMMA RAYS BY MEANS OF THE MOESSBAUER EFFECT. Olsen, J. (Danish Atomic Energy Commission, Riso). Nucl. Instrum. Methods, 70: 109-11 (Apr. 1, 1969).

Recoil-free 14.4-keV gamma rays from ^{57}Fe are reflected from an aluminum single crystal. By measurements of the intensities of the peaks in the Moessbauer spectra, the polarization at different Bragg angles is determined. (auth)

23250 EXPERIMENTAL DETERMINATION OF THE ENERGY LOSS OF PROTONS CHANNELED THROUGH AN ALUMINIUM SINGLE-CRYSTAL. Blanchin, D.; Poizat, J.-C.; Remillieux, J.; Sarazin, A. (Univ., Lyon). Nucl. Instrum. Methods, 70: 98-102(Apr. 1, 1969).

An indirect method of determination of the energy loss of channeled particles in a single-crystal is described in the particular case where the incoming protons can induce a (p,γ) reaction in the target. In this way dechanneling effect as a function of depth in the crystal was studied by means of both (p,γ) reaction and Rutherford scattering. This method was applied to 1.4-MeV protons channeled through an aluminum single crystal along a [110] direction. Stopping power of aluminum crystal for protons incoming along a [110] direction, normalized to the "normal" stopping power was computed from our experimental results, and it was found to be 0.35 ± 0.02. (auth)

23251 ION-INDUCED RE-EMISSION OF NOBLE GAS ATOMS FROM POLYCRYSTALLINE TUNGSTEN. I. Erents, K. (Culham Lab., Abingdon, Eng.); Carter, G. J. Phys., D (London), 2: 435-40(Mar. 1969).

A technique for measuring the rate of release of a primary trapped ion species from tungsten when subjected to a second ion species is described. Preliminary data show that gas release rates are generally much larger than would be anticipated from a mechanism based upon erosion of the tungsten with attendant gas emission, and that the second ion species releases the primary gas by some form of efficient energy-transfer process. (auth) (UK)

23252 ELECTRONIC STRUCTURE OF THORIUM METAL. I. RELATIVISTIC AUGMENTED-PLANE-WAVE CALCULATION. Gupta, R. P. (Ames Lab., Iowa); Loucks, T. L. Phys. Rev. Lett., 22: 458-61(Mar. 10, 1969).

A theoretical Fermi-surface model is presented for Th. It is in qualitative agreement with the earlier experimental results of Thorsen et al., and with the more recent results of Boyle and Gold. It is concluded that Th is very similar to the fcc transition metals. (auth)

23253 ELECTRONIC STRUCTURE OF THORIUM METAL. II. THE de HAAS–van ALPHEN EFFECT. Boyle, D. J.; Gold, A. V. (Ames Lab., Iowa). Phys. Rev. Lett., 22: 461-3(Mar. 10, 1969).

High-resolution studies of the de Haas–van Alphen effect in thorium, although not yet complete, are found to provide strong support for the validity of a new model for the Fermi surface proposed by Gupta and Loucks in a companion paper. (auth)

23254 NUCLEAR MAGNETIC RESONANCE AT HIGH FIELDS. Becconsall, J. K.; McIvor, M. C. (ICI's Petrochemical and Polymer Lab., Runcorn, Eng.). Chem. Brit., 5: 147-53(Apr. 1969).

Measurement of a nuclear magnetic resonance spectrum at high field reduces complicating second-order effects and increases sensitivity. This has long been recognized, but conventional magnets are limited in strength and the high flux densities required have only been achieved since the introduction of superconducting magnets. The operation and achievements of a 220-MHz spectrometer are described. (auth)

23255 CHARACTERISTIC AUGER ELECTRON EMISSION AS A TOOL FOR THE ANALYSIS OF SURFACE COMPOSITION. Riviere, J. C. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Bull. (London), 20: 85-91(Mar. 1969).

Existing techniques for surface studies are reviewed in the light of their inability to analyze very thin, down to submonolayer, surface films. The Auger electron technique is then described in detail, including the mechanism and efficiency of production of Auger electrons; also detection methods. Experiments that have used Auger emission spectroscopy are described. It is concluded that the technique would appear to fulfil the need for a means of chemical analysis of material in the form of very thin films on surfaces. The technique does not require single crystal specimens, and is most sensitive in the low atomic number region. A difficulty may be the requirement of a good vacuum around the specimen. (UK)

23256 OXYGEN ISOTOPIC CONCENTRATION GRADIENT DETERMINATION WITH THE CAMECA ION MASS ANALYZER. Contamin, P. (CEN, Grenoble, France); Slodzian, G. Appl. Phys. Lett., 13: 416-17(Dec. 15, 1968).

The ionic mass analyzer, built by Castaing and Slodzian, has been used for the determination of oxygen isotopic diffusion concentration gradients in massive uranium dioxide samples. Two methods have been investigated: image formation from surface isotopic distributions and ionic current measurements along the axis of diffusion. (auth)

23257 INTERACTION BETWEEN RADIATION DEFECTS AND IMPURITIES IN P-TYPE Si. Nakashima, Kenshiro; Inuishi, Yoshio. Technol. Rep. Osaka Univ., 18: 415-23(Oct. 1968).

The interactions during the high-temperature annealing process between impurities (such as oxygen, copper, and nickel) and complex defects introduced in p-type Si with γ irradiation (such as an A center) were studied. The nature of the reverse annealing was investigated in detail. The tentative speculation on this phenomena is proposed as follows: if an A center encounters the interstitial oxygen at high temperature, they may form a new large complex defect that causes a remarkable reverse annealing of inverse lifetime. This speculation seems to be supported by the isochronal annealing of floating-zone samples in the wet oxygen gas ambient; floating-zone samples that do not show the reverse annealing in air or dry nitrogen gas ambient show the same reverse annealing as pulled samples in the case of annealing in wet oxygen gas ambient. When the floating-zone samples irradiated with γ rays are annealed in silicone oil containing impurities such as copper or nickel, a drastic decrease of minority carrier lifetime occurs, resulting in the increase of the unannealed part of the lifetime. In the case of neutron irradiation, no reverse annealing is observed as published previously. A possible interpretation of such interaction between impurities and an A center is discussed. (auth)

23258 NUCLEAR QUADRUPOLE COUPLING CONSTANTS. Lucken, E. A. C. London, Academic Press, 1969. 370p. 100s.

The subject is treated under the following chapter headings: Introduction; theory of nuclear quadrupole interaction; experimental determination of quadrupole coupling constants; nuclear quadrupole coupling constants in atoms; Sternheimer shielding; exact calculations of field gradients; approximate methods; environmental effects on nuclear quadrupole coupling constants; Stark effect in pure quadrupole resonance; halogen coupling constants of organo-halogen compounds; ^{14}N quadrupole coupling constants; quadrupole coupling constants of compounds of typical elements of periodic table; compounds of transition and rare earth elements; and charge transfer complexes. (UK)

23259 ON THE QUESTION OF DIPOLAR QUENCHING OF NMR FINE-STRUCTURE LINES. POTENTIAL POSSIBILITIES OF THE USE OF DIAGONAL SUM METHODS FOR THE TREATMENT OF MUTUALLY DEPENDENT BROADENING MECHANISMS. Svanson, S. E. (Univ. of Gothenbrug, Sweden). Ark. Fys., 38: 489-97(1968).

It is pointed out that diagonal sum methods may be used quite generally to calculate the characteristic features of magnetic resonance spectra exhibiting resolved structures as well as only one smooth spectral line. The effect of mutual dependence between different broadening mechanisms on the spectral shape was investigated for some special cases using such methods. It is concluded that the relevant formulae for moments and spectral correlation functions of purely dipole coupled systems are equally applicable to spectra separated into resolved components, due to the presence of dominating dipolar interaction terms, as to smooth spectral lines. This means that the proton structure of substances containing protons in demarcated groups may be studied successfully even from the proton resonance of substances with complicated structures and only partially resolved spectral patterns. The size of the main interaction terms may in such cases be determined from the spectral correlation function, which easily can be calculated with quite sufficient accuracy for nuclei of spin one-half. (auth) (Sweden)

23260 ON FORBIDDEN TRANSITIONS AND DISCRETE SATURATION IN EPR LINES. Sanadze, T. I.; Khutsishvili, G. R. Zh. Eksp. Teor. Fiz., 56: 454-61(Feb. 1969). (In Russian).

The mechanism of pulsed saturation of nonuniformly broadened EPR lines whose width is due to nuclei surrounding the paramagnetic center is considered. It is shown that the presence of a complex spectrum of the super hyperfine structure, when the probabilities for reorientation of nuclear spins in an electron transition are comparable to probabilities for transitions not involving changes in the nuclear spin projection, may be one of the causes of discrete saturation in EPR lines. As an example, discrete saturation in the EPR line in irradiated polyethylene is examined. (auth)

23261 DETECTION OF THE STATIC MAGNETIC FIELD PRODUCED BY THE ORIENTED NUCLEI OF OPTICALLY PUMPED ^{3}He GAS. Cohen-Tannoudji, C.; DuPont-Roc, J.; Haroche, S.; Laloee, F. (Ecole Normale Superieure, Paris). Phys. Rev. Lett., 22: 758-60(Apr. 14, 1969).

A new type of very sensitive low-field magnetometer is used to detect the static magnetic field produced by optically pumped ^{3}He nuclei in a vapor. Various signals (pumping and relaxation transients) are obtained in this way. This magnetostatic detection allows a direct study of ^{3}He nuclear polarization without perturbing the spins. (auth)

23262 ELECTRIC RESISTANCE MINIMUM OF LUTETIUM FILMS. Lazarev, B. G.; Kuzmenko, V. M.; Sudovtsov, A. I. (Physical-Technical Inst., Kharkov). Dokl. Akad. Nauk SSSR, 184: 815-16(Feb. 1, 1969). (In Russian).

The electric resistance minimum of 300 to 8000 Å lutetium films prepared by condensation on glass surfaces and cooled by liquid helium was studied, after condensation and annealing temperature of T = 300 to 400°K. The experiments used lutetium with $R_{300°K}/R_{4.2°K} = 15$ and 99.9% purity. The magnitude of the minimum $\Delta R/R = (R_{15°K}$ to $R_{T\min})$ increased with diminished thickness and varied from ~0.004% for films with ~7500 Å thickness to 0.13% with films with ~300 Å thickness. The depth of the minimum following the annealing diminished in proportion to the increased thickness of the metal. Measurements of electric conductivity perpendicular to the film plane magnetic field showed that the field up to 25,000 Oe does not influence the magnitude and temperature of the minimum. The resistance of Lu films in a field of 25,000 Oe at temperature of 4.2°K increased from 0.02 to 0.03%. (R.V.J.)

23263 ANISOTROPY OF SPIN-LATTICE RELAXATION IN ErES AND SmES. Borchi, E. (Univ., Florence); De Gennaro, S.; Mancini, M. Nuovo Cim., Lett., 1: 502-4(Apr. 1, 1969).

Relaxation in rare-earth salts has been considered theoretically by Orbach who uses a very approximate approach to estimate relaxation times. The theory has been re-examined by the authors in terms of the normal modes of the vibrating charge complex surrounding the paramagnetic ion. A point charge model has been adopted and the case of Sm^{3+} in ethylsulfate has been discussed. However in the case of ethylsulfates, where the crystalline field is due to the water molecules, the point charge model is not entirely satisfactory. That is, the distribution of charge in the water molecule does not possess spherical symmetry. The crystal field arises predominantly from the dipole moments of the water molecules. (auth)

23264 THEORY OF INELASTIC SCATTERING OF ELECTRONS IN CRYSTALS. Kasper, Erwin (Univ., Tuebingen, Ger.). Z. Phys., 222: 225-42(1969). (In German).

A general solution of the basic equations of electron diffraction in crystals is found which shows that each state of a diffracted electron can be described as a linear superposition of Bloch waves with amplitudes varying in the direction normal to the entrance surface of the crystal. For each state the Bloch waves composing it belong to the same wave vector but are eigenfunctions of different energy bands. The absorption effect can be described by the variation of the amplitudes which can be calculated by solution of a system of linear homogeneous differential equations of first order. Since this variation is different for every state, a dispersion effect is coupled with the absorption. The mathematical structure of this solution is the same for elastic and inelastic scattering, and thus both kinds of transitions may contribute to the dispersion and absorption mechanism. In the case of fast electrons the amplitudes vary slowly; the wave functions of the electron states then have a local translation symmetry. By averaging over unit cells of the lattice simple expressions for the particle- and current densities are found for which the conservation of total electron flux can be shown directly. From the differential equations of the amplitudes an equation can be derived which permits a direct proof that a dissipation process occurs in the crystal. By the same equation it can also be seen that the description of electron absorption by use of an imaginary periodic crystal potential can only be a rough approximation. (auth)

23265 MAGNETIC STUDIES OF RARE EARTH–ZINC COMPOUNDS WITH CsCl STRUCTURE. Kanematsu, K.; Alfieri, G. T.; Banks, E. (Polytechnic Inst., Brooklyn). J. Phys. Soc. Jap., 26: 244-8(Feb. 1969).

Magnetic studies of rare earth–zinc compounds with CsCl structure indicate that heavy rare earth compounds (Gd to Er) are ferromagnetic and light rare earth ones (except SmZn) are paramagnetic (antiferromagnetic). SmZn behaves like a ferromagnetic material with magnetic moment, 0.07 μ_B/Sm. The dependence of exchange interactions on interatomic spacing is discussed in comparison with the behavior of rare earth–cadmium compounds. (auth)

23266 ENERGIES OF DISLOCATIONS IN α-URANIUM. Saxl, I.; Otruba, J. (Nuclear Research Inst., Prague). Czech. J. Phys., 19: 456-63(1969).

The temperature and angular dependence of the dislocation energy is calculated using anisotropic elasticity for dislocations pertaining to the principal slip systems in α-uranium. The results are compared with the isotropic estimate; for screw dislocations the difference is quite considerable. The stability of dislocations with Burgers vectors out of the (001) plane is also briefly covered. (auth)

23267 PULSED NMR BY TONE-BURST GENERATION. Look, D. C.; Locker, D. R. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Chem. Phys., 50: 2269-70(Mar. 1, 1969).

Using a tone-burst generator it is possible to do pulsed nuclear magnetic resonance on an otherwise unmodified, wide-line, continuous-wave spectrometer. Here a General Radio Model 1396B tone-burst generator was applied to a Varian Model V-4200B wide-line NMR spectrometer. The method and its advantages are discussed. Results of a pulse sequence in Mn^{2+}-doped H_2O are presented. (M.H.R.)

23268 Y^{2+} AS A COLOR CENTER IN IRRADIATED CaF_2. Theissing, H. H.; Ewanizky, T. F.; Caplan, P. J.; Grosse, D. W. (Army Electronics Command, Fort Monmouth, N. J.). J. Chem. Phys., 50: 2657-71(Mar. 15, 1969).

The absorption spectrum of blue, γ-irradiated $CaF_2 : Y^{3+}$ crystals shows several bands in the visible region whose intensity is roughly proportional to the yttrium concentration. Bleaching into the individual bands indicates that more than one center is responsible for the whole spectrum. Inconsistent color response of various crystal samples to γ irradiation suggests that only the crystals with sufficient Y^{3+} in cubic sites, i.e., with the charge compensator some distance away, are colorable. In this case the Y^{2+} formed by γ irradiation and the defects produced at the remote charge compensators become color centers and share in the generation of the spectral bands. The question of which band(s) would be due to Y^{2+} is examined by fitting the band frequency to the energy difference "e"–"t" of the cubic field-split d^1 level of Y^{2+} and the bandwidth to the spread of the "t" level into its components due to a dynamic Jahn–Teller effect. The best fit turns out to be the 17 500-cm^{-1} band, which yields reasonable values for cubic field strength Dq, vibrational displacement of F^- ions, and Jahn–Teller energy. (auth)

23269 ELECTRON-SPIN-RESONANCE LINEWIDTH VARIATION WITH TEMPERATURE IN SOME RARE-EARTH SALTS: T_1/T_2 RATIOS. Stapleton, H. J. (Univ. of Illinois, Urbana); Brower, K. L. Contract SD-131. Phys. Rev., 178: 481-5 (Feb. 10, 1969).

The temperature dependence of the electron-spin resonance linewidth of Ce, Nd, and Sm in lanthanum magnesium nitrate was from below 4°K to as high as 26°K. Both Ce and Nd displayed a linewidth which was essentially Lorentzian at the lowest temperature and which broadened with increasing temperature in accordance with an Orbach relaxation mechanism. A comparison of the strength of this broadening with standard relaxation measurements below 4°K indicated that T_1/T_2 was 8.6 for the Nd sample and was estimated to be 13 for the Ce crystal. Sm displayed a temperature-dependent broadening which could be interpreted as due either to a Raman or an Orbach mechanism. (auth)

23270 T_1 AND T_2 FOR ORBACH RELAXATION PROCESSES. Culvahouse, J. W.; Richards, Peter M. (Univ. of Kansas, Lawrence). Contract AT(11-1)-1488. Phys. Rev., 178: 485-95 (Feb. 10, 1969).

The master equation for the density matrix of the ionic levels involved in the relaxation process described by Orbach is developed in a form valid for low temperatures. In the absence of degeneracies, the equations for the diagonal elements of the density matrix are the rate equations for the populations which have been solved before; and the equations for the off-diagonal elements show that $(1/T_2)$, the linewidth for a transition between two levels, is given by one-half the sum of the phonon-induced rates out of those levels. Cases in which the inverse lifetimes of the excited states are not small compared with the splitting of the doublets are investigated, and it is found that the modification of T_1 can be quite significant, but that the effect of T_2 is slight in all cases. For Ce^{3+}, Nd^{3+}, and Sm^{3+} in the double nitrates, it is found that $T_1 = T_2$ within 12.5% for the magnetic field perpendicular to the symmetry axis for all conditions. For Ce^{3+} in LaMg double nitrate with the field perpendicular to the symmetry axis, measurements at 10 Gc/sec should give $T_1 = T_2$ within 3%, whereas the experimental result reported by Stapleton and Brower is $T_1 = 13T_2$. It is found that spin–spin interactions between the ground doublet and the excited doublet cannot be the cause of the discrepancy, but that a near-universal bottlenecking of a part of the phonon modes would lead to an explanation of the linewidth measurements and not be at variance with the size and concentration dependence of T_1 thus far reported for the double-nitrate crystals. This hypothesis is based on the calculations of Orbach and Vrederoe, which show that the lifetime of the transverse phonon modes may be much longer than that for the longitudinal modes. Further, the transverse phonons should produce the greater part of the orbit–lattice interaction. This hypothesis suggests that a true spin–lattice T_1 would be measured only at very low concentrations, and that with increasing concentrations a bottleneck would develop so that the apparent relaxation time would increase with concentration until the bottlenecked relaxation became comparable with the rate due to other unbottlenecked phonons acting in parallel with the bottle-necked phonons. The experiments of Adde and Geschwind appear to show some aspects of this behavior. (auth)

23271 COHERENCE AND POLARIZATION EFFECTS IN MOESSBAUER ABSORPTION BY SINGLE CRYSTALS. Housley, R. M.; Grant, R. W.; Gonser, U. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Rev., 178: 514-22(Feb. 10, 1969).

The polarization dependence of the absorption cross section must generally be taken into account in calculating Moessbauer absorption spectra of single crystals which exhibit hyperfine splittings. A method for doing this in an experimentally interesting class of cases is described. In these cases, the incident radiation beam can be divided into two components, each having its own complex index of refraction. A number of conditions under which this division is always possible are described in terms of crystal symmetry considerations. Also, a practical method of computing the polarization of the cross section in terms of the hyperfine interactions for arbitrary nuclear transitions is described. A representation of the polarization in terms of a 2 × 2 density matrix is introduced which is convenient in cases where two or more nuclear transitions overlap in energy and in cases where resonant nuclei are located at several different or crystallographically equivalent but differently oriented sites in the crystal. A method for applying these results to an analysis of data to obtain electric-field-gradient parameters, mean square displacements, and magnetic structures is outlined. (auth)

23272 MOESSBAUER-EFFECT MEASUREMENTS OF THE THERMAL SHIFT OF ^{119}Sn IN β-Sn BELOW 90°K. Snyder, N. S. (Harvard Univ., Cambridge, Mass.). Contract Nonr 1866 (56). Phys. Rev., 178: 537-43(Feb. 10, 1969).

The shift in the resonant absorption energy of the 23.9-keV transition of ^{119}Sn was observed as the temperature of a β-tin Moessbauer absorber was varied between 90 and 3.6°K. The metallic ^{119m}Sn source was kept at constant temperature. A continuously calibrated slope-detection method was employed. The standard deviations of the fractional energy shifts observed were about 0.8 parts in 10^{15}, or 3% of the total thermal shift of approximately 26×10^{-15} measured between 77 and 4°K. Earlier measurements of the thermal shift in metallic tin had a statistical accuracy of about 40% over 100°K, and were not extended below 77°K. Such observations were interpreted on the basis of the relativistic time-dilation effect. Because of the improved accuracy of the present measurements, it has been necessary to consider also the temperature variation of the isomer shift and of the quadrupole asymmetry of a preferentially aligned sample in assessing the agreement with theory. The recrystallization texture of the 27-μ absorber foil was analyzed by x-ray methods. A search for a possible small shift in energy at the superconducting transition in tin was also made, using the same apparatus. Measurements were made by alternating the absorber temperature above and below the transition temperature every few minutes. The results indicated no change in the absorption energy within the limits of 0.8 parts in 10^{15}, in accord with previous studies. (auth)

23273 PSEUDOQUADRUPOLE SHIFT AND ASYMMETRIC LINE BROADENING OF RECOILESS NUCLEAR RESONANCE SPECTRA. Clauser, M. J. (Technische Hochschule, Munich. Sandia Labs., Albuquerque, N. Mex.); Moessbauer, R. L. Phys. Rev., 178: 559-67(Feb. 10, 1969).

Large, temperature-dependent line shifts and asymmetric line broadenings have been observed in the recoilless nuclear resonance spectra of several rare-earth compounds. The shifts are shown to be due to a second-order magnetic hyperfine interaction, while the broadenings are partially attributed to electron spin–spin relaxation. A detailed theoretical analysis of the line shifts is presented and shown to agree well with experimental observations in $TmCl_3 \cdot 6H_2O$. (auth)

23274 MAGNETO-ELASTIC INTERACTIONS IN GADOLINIUM. Long, M. Jr.; Wazzan, A. R.; Stern, R. (Univ. of California, Los Angeles). Phys. Rev., 178: 775-80(Feb. 10, 1969).

The effect of the change in easy direction of magnetization on the elastic constants c_{33} and c_{44} has been measured in single-crystal gadolinium by means of a pulse-echo technique. One of the constants c_{33} exhibited a sharp decrease of about 2% over the temperature range −37 to −51°C after which it slowly returned to its normal, monotonic increasing behavior with decreasing temperature. Magnetic fields of up to 8 kOe, either parallel or perpendicular to the unique axis of the hexagonal crystal, were applied to the sample. These decreased the absolute magnitude of the change in c_{33}. It is thought that the acoustic wave is coupled to the spin structure by volume magnetostriction. (auth)

23275 LOW-ENERGY ELECTRON SCATTERING FROM CLEAN AND HYDROGEN-COVERED Nb (110) SURFACES. Haas, T. W. (Aerospace Research Lab., Wright-Patterson AFB, Ohio). J. Appl. Phys., 39: 5854-8(Dec. 1968).

Low-energy electron diffraction (LEED) and inelastic electron scattering (IES) measurements are used to characterize the chemisorption of hydrogen onto the Nb (110) surface. It is found that hydrogen chemisorbs readily at room temperature, causing no rearrangement or faceting of the surface, and with only small changes in the work function. Distinctive changes in the intensity curves indicate that the hydrogen is chemisorbed in a crystalline layer with the same lattice structure as the Nb (110). Removal of the hydrogen is easily accomplished by heating to 400°C, and residual gas measurements show a higher mass 1 peak than usual, indicating that the hydrogen is adsorbed as atoms. Changes in both the LEED intensity curves and in the IES measurements both suggest that the beam penetrates more deeply into the crystal when hydrogen is chemisorbed than for the clean surface. (auth)

23276 SPIN–LATTICE AND CROSS RELAXATION OF ^{54}Mn NUCLEI IN DILUTE PARAMAGNETIC CRYSTALS. Lubbers, J.; Huiskamp, W. J. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 34: 166-92(1967).

The relaxation of nuclei of radioactive ^{54}Mn in crystals of lanthanum magnesium nitrate is studied as a function of Ce concentration, magnetic field, and temperature. The nuclear orientation is derived from the γ-ray anisotropy. Nuclear spin–lattice relaxation times of 10^1 to 10^5 sec were measured and interpreted by electronic spin-lattice relaxation in conjunction with forbidden transitions, i.e., nuclear spin flips. Generally a Ce concentration of more than 1% is required in order to influence this relaxation significantly. When the sample is cooled at a fast rate, the Ce spins can induce forbidden transitions (e.g., $S_z = -5/2$, $I_z = +3 \rightarrow S_z = -3/2$, $I_z = +2$) in the Mn spin system, which process generates a population of the nuclear levels which strongly deviates from thermal equilibrium as was shown by the observation of anomalous nuclear orientation. An analysis of this process is given. (auth)

23277 POSSIBLE ORIGIN OF "ANOMALOUS CHARGE STATES" IN MOESSBAUER SPECTRA. Hazony, Y. (Princeton Univ., N. J.); Herber, R. H. J. Inorg. Nucl. Chem., 31: 321-7 (Feb. 1969).

The formation of iron atom charge states both more and less positive than the charge state of the cobalt atom in the parent compound was observed in ^{57}Fe Moessbauer experiments on inorganic solids. While the persistence of more positive charge states can be rationalized as a consequence of an internal conversion–Auger cascade process, the mechanism for the formation of less positive charge states has so far not been clearly understood. Recent experiments by Drickamer et al. on inorganic ^{57}Fe Moessbauer absorbers showed that ferric compounds under pressure give isomer shifts and quadrupole splittings normally associated with ferrous complexes. This phenomenon may be able to account for the observation of the "anomalously" low charge states of ^{57}Fe formed from ^{57}Co in an ionic cobaltic ion lattice, since the ionic radius difference between the two transition metal ions can manifest itself as an "internal pressure" at the metal ion lattice site. This working hypothesis is examined in some detail in the light of existing information pertaining to the compressibilities and charge states of iron compounds and to the nature of the nuclear precursor event in ^{119}Sn Moessbauer experiments. (auth)(UK)

23278 COLOR CENTERS IN VITREOUS AND CRYSTALLINE $Na_2B_4O_7$. Bettinali, Carlo; Granati, Paolo (Univ., Rome). Atti. Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 44: 669-79 (May 1968).

Results are compared of ^{60}Co γ-ray-induced centers in fused borax and crystalline anhydrous borax. Optical absorption, electron spin resonance, thermoluminescence glow curves, and thermoluminescence spectra were studied. The formation of color centers in materials prepared by heating a unique sample (i.e., having the same number of impurities) is very different according to the data; amorphous, glassy, or crystalline. Differences are both qualitative (different types or formed centers) and quantitative (lesser efficiency of center formation). The formation of defects stable at room temperature is more efficient in glasses. This fact seems to confirm the presence of diffusion mechanisms in the color center formation in glasses. (auth)

23279 Y-ABSORPTION BAND IN IRRADIATED LiF. Bohun, Antonin (Institut fuer Festkoerperphysik, Prague). Z. Phys., 222: 58-66(1969). (In German).

The absorption measurements at a constant and uniformly increasing temperature and the thermostimulated electron emission and luminescence of α-, cathode-, and γ-ray irradiated LiF crystals were performed and the conditions of the formation of a new absorption band at about 500 nm investigated. It turned out that the band in α-irradiated samples is composed from two and is γ-irradiated from three bands. In this case the short-wave-length-band with the zero-phonon-line at 491 nm is very probably the well known F_3^+-band. The long-wave-length-band with the zero-phonon-line at 507 nm (the X band) is of unknown nature. The Y band lies at 494.3 nm (at 77°K) and its nature could consist in the color center agglomerates. (auth)

23280 INVESTIGATIONS OF MAGNETIC PHASES OF INTERMETALLIC ERBIUM COMPOUNDS. Petrich, Georg (Technische Hochschule, Munich). Z. Phys., 221: 431-50(1969). (In German).

The Moessbauer effect of the 80.6-keV γ transition of ^{166}Er was employed to study the temperature dependence of the nuclear hyperfine splitting of ^{166}Er. The Er isotope was introduced into the intermetallic compounds $ErCo_2$, $ErCo_{1.5}Ni_{0.5}$, ErCoNi, $ErNi_2$, and ErAg. Except for $ErCo_2$, all the compounds exhibit a behavior typical for electronic relaxation phenomena. The system $ErCo_2$ shows at 35°K a magnetic phase transition of the first order which is discussed in the framework of the theory of Bean and Rodbell. Calorimetric data, low-temperature x-ray measurements, and magnetization data are in agreement with the Moessbauer data. In ErAg and in $ErNi_2$, the Er^{3+} moment is partially quenched by the interaction with the crystalline electric field. The $ErCo_2$ data may be interpreted in terms of an undisturbed $^4I_{15/2}$-multiplet (auth)

23281 RADIATION DAMAGE AND ADSORPTION AS STUDIED BY THE METHOD OF EXOELECTRON EMISSION. Baasov, D. I.; Kolbanovskii, Yu. A.; Polak, L. S. (Inst. of Petrochemical Synthesis, Moscow). Int. J. Radiat. Phys. Chem., 1: 53-66(Jan. 1969). (In Russian).

The principles for applying exoelectronic emission to the investigation of the surface damage caused by radiation are given. An improved method is described, which provides a high counting efficiency. The extinction of the emission (T = 300°K) for γ-Al_2O_3 was followed at various doses and dose rates of radiation. A rough value (≈0.2 eV) is given for the activation energy of the exoelectrons at room temperature. The curves of the thermostimulated exoelectronic emission (TSEE) at various doses and dose rates of radiation are given, which characterize the influence of the population of the various local levels (defects) on the emission properties of crystals. It is shown that the number of emitted electrons rises by increasing the radiation dose; at the same time the deeper traps in the forbidden zone are filled. The kinetics of the extinction of the exoelectronic emission for γ-Al_2O_3 vs the number of chemisorbed atoms of hydrogen indicate an increase during chemisorption of the total number of centers which are capable of emission and have the character of donors, and at the same time the energetic distribution of the traps changes. It was shown that the adsorption causes the appearance of a new distinct maximum on the TSEE curve; the height of this maximum depends on the quantity of hydrogen adsorbed. This indicates that new emission centers have appeared. The position of the maximum determines the depth of the admixture level formed by the chemisorbed atoms in the forbidden zone. The influence of the isotope effect on the course of the thermostimulated emission before and after the adsorption of hydrogen and deuterium was investigated. The first maximum on the curve of γ-Al_2O_3 + deuterium is shifted in comparison with the maximum on the curve of γ-Al_2O_3 + hydrogen. It is supposed that electron traps in the surface formed under the influence of the adsorption of deuterium are situated on deeper energy levels than those formed during the adsorption of hydrogen. (auth)

23282 NUCLEAR MAGNETIC RESONANCE STUDY OF THE LIGHT RARE EARTH HYDRIDES: MAGNETIC PROPERTIES AND CONDUCTION BAND STRUCTURE. Kopp, Jay Patrick. Evanston, Ill., Northwestern Univ., 1968. 176p.

Thesis.

In order to investigate some basic questions about the electronic structure of the rare earth–hydrogen alloys, a nuclear magnetic resonance study of the light, magnetic REH_x systems was carried out. The investigation consisted primarily of determining the dependence of the ^{1}H NMR on hydrogen concentration (x) and temperature in the REH_x systems (where RE = Ce, Pr, Nd, Sm, and Gd, with $2 \leq x < 3$). The major portion of the work was performed at temperatures between 4.2 and 77°K, for which an exchange gas cryogenic system was constructed. All the systems were found to have large positive (negative for GdH_x), temperature-dependent ^{1}H Knight shifts. These shifts are due to an enhancement of the conduction electron polarization by the local atomic moments present on the rare earth ions. The polarization of the conduction electrons is manifested in two ways: by the NMR Knight shifts resulting from the nuclear hyperfine interaction and by furnishing an indirect coupling of the atomic moments which has an important influence on the magnetic ordering properties of these systems. The experimental results may be divided into three categories: (1) evaluation of the density of electrons associated with the hydrogen nuclei by means of a Rudermann–Kittel–Kasuya–Yosida (RKKY) analysis of the ^{1}H NMR Knight shifts; (2) the effect that the alloying process has on the occupation of conduction band states, as seen by the dependence on concentration of the ^{1}H NMR line shift and width; and (3) the observation of magnetic ordering and the determination of magnetic ordering temperatures. Taking the latter category first, previously unreported magnetic ordering has been observed in the CeH_x and PrH_2 systems. The ordering temperatures in CeH_x (of the order of 5°K for $x < 2.5$) are found to be strongly concentration dependent and the concentration dependence is correlated with the Knight shift behavior. The $PrH_{2.0}$ system orders at $T_0 = 2.40 \pm 0.05$°K, but the PrH_x systems for $x \geq 2.1$ show a quite different magnetic behavior. Magnetic ordering is also seen in the other systems studied. Using the RKKY theory and choosing parameters for the REH_x systems based on the results found in allied systems, an evaluation of the fraction of s electrons per hydrogen nucleus (ξ) is made. This fraction is found to be small for all systems ($\xi \sim 0.14$ for CeH_x, $\xi \sim 0.19$ for PrH_x and $\xi \sim 0.3$ for NdH_x), and is more consistent with a "protonic" model for the hydrogen solute. A simplified rigid band model for the conduction band structure, consisting of two 5d subbands, is proposed to explain the dependence on concentration of the ^{1}H NMR shifts and the ordering temperatures. An additional effect is observed in the PrH_x system which is qualitatively explained in terms of a valence change of the Pr^{3+} ion and the proposed conduction band structure. Simple point charge models for the crystalline electric field effects on the magnetic properties of the ions are found to be inadequate. (Disser. Abstr.)

23283 ELASTIC AND MAGNETIC STUDIES OF URANIUM DIOXIDE. Brandt, Ogden Grenville. Evanston, Ill., Northwestern Univ., 1968. 167p. Thesis.

Uranium dioxide exhibits anomalous behavior in both its magnetic and elastic properties. At 30.6°K, it undergoes a first-order paramagnetic-to-antiferromagnetic phase transition in contrast to the usual second-order magnetic transition, while the thermal conductivity suffers an unusually large drop near the transition. An investigation was conducted to determine the nature of the coupling between the atomic elastic and magnetic properties implied by the thermal conductivity results, by means of the propagation of ultrasonic waves. The three independent elastic constants (C_{11}, $C' = C_{11} - C_{12}$, and C_{44}) were measured from room temperature to 10°K, and the attenuation of the sound waves associated with these elastic constants was measured from 70 to 10°K. In addition, the magnetic susceptibility was measured in the principal crystallographic directions over the temperature range from 300 to 4.2°K, as were the length changes upon cooling through the transition. Finally, the determination of pressure and magnetic field effects on the elastic constants and attenuation was attempted; however, null results were obtained. Of the three elastic constants, C_{44} showed anomalous behavior from room temperature down to the transition; over a wide temperature range it relaxed upon cooling with a 1/T dependence. All three elastic constants showed discontinuous behavior at the transition. Again, sound waves associated with C_{44} had singular behavior as evidenced by a very large attenuation above and below the transition; indeed it was found to be impossible to propagate sound waves within about five degrees of the transition. C_{11} and $C_{11} - C_{12}$ evidenced small attenuation peaks at the transition temperature. The magnetic measurements showed that in the antiferromagnetic state, the crystals were magnetically multidomain; the results confirmed the work of others on powdered specimens, which are necessarily multidomain. The length change at the transition was found to be too small to explain the first-order character of the transition in terms of an exchange-striction mechanism. From the 1/T dependence of C_{44} it is postulated that this elastic constant is strongly affected by a "Jahn–Teller" interaction, in which the ground state energy of the degenerate uranium valence electrons is influenced by elastic distortions of the lattice. This postulate was used to determine a Jahn–Teller splitting energy $\alpha_{rms} = 722$ cm^{-1} per unit strain and, with somewhat less certainty, an average potential barrier between split states of the uranium valence electrons of about 70°K. Additionally, an attempt frequency is estimated to be about 2.4×10^{11} sec^{-1}. After removal of the Jahn–Teller contribution to C_{44}, a qualitative agreement between the behavior of all three elastic constants at the transition and the behavior of the corresponding elastic constants of NH_4Cl and NH_4Br was found. These materials undergo an analogous transformation although the correspondence is not perfect. The pertinent theories to explain first-order transition behavior and elastic constant behavior were reviewed, as well as some recent work aimed specifically at UO_2. (Disser. Abstr.)

23284 FARADAY ROTATION STUDIES OF AN R-LIKE CENTER IN NEUTRON-IRRADIATED MgO. Glaze, James Alexander. Eugene, Oreg., Univ. of Oregon, 1968. 99p. Thesis.

Zero-phonon lines at 5233, 6419, and 6490 Å appearing in the optical absorption spectrum of neutron-irradiated MgO have been shown by other workers to be consistent with centers having trigonal symmetry about the (III) direction and possessing $E \rightleftharpoons A$ electronic transitions. The technique of optical Faraday rotation is used here to study the lines at 5233 Å and 6419 Å which correspond to $E \rightarrow A$ and $E \leftarrow A$ transitions, respectively. It is shown by examination of temperature and magnetic field variations in the Faraday rotation spectrum, that the line at 5233 Å is associated with a paramagnetic center. This rotation is shown to vary as 1/T in the range 1.81 to 4.22°K for fields less than 10 kG. The field dependence is linear up to 40 kG at 4.2°K but at 1.81°K it shows strong saturation behavior from 10 kG to 55 kG. The resulting saturation curve can be fitted to tanh (gBH/2kT) for a g value near 2. Since a g value of 2 implies that the center possesses an unpaired electron whose spin is essentially decoupled from its orbital motion, it is apparent that the orbital angular momentum associated with the E ground state is quenched. A theoretical model for the Faraday rotation is then proposed in which the quenching is viewed as arising from random splitting of the ground state as well as a dynamical Jahn–Teller interaction between the degenerate E electronic states and a pair of degenerate E vibrational modes. This model is then used to make the following estimates: $0.03 \lesssim b\Lambda \lesssim 0.07$ and $1\ \mathrm{cm}^{-1} \lesssim T_R \lesssim 2\ \mathrm{cm}^{-1}$, where $b\Lambda$ is the reduced electronic orbital angular momentum and T_R is the reduced spin-orbit splitting. The center at 6420 Å fails to exhibit any rotation for fields as high as 50 kG and temperatures as low as 1.81°K. This behavior is consistent with a diamagnetic center possessing quenched orbital angular momentum in the excited E state. Finally, the significance of the preceding results are discussed in relation to various models that have been proposed for these centers. (Disser. Abstr.)

23285 THE PRODUCTION OF V AND F CENTRES IN KCl AT 295°K. Goldstein, F. T. (Atomic Energy Research Establishment, Harwell, Eng.). Solid State Commun., 7: 475-8 (Mar. 1, 1969).

A study of the optical growth of V and F bands in electron-irradiated room temperature KCl showed that V bands grow in direct proportion to the F band in pure samples; the effects of OH^-, Br^-, and I^- impurities are discussed. (auth)

23286 PRODUCTION OF COLOUR CENTRES IN POTASSIUM CHLORIDE BY 5-keV ELECTRONS. Soul, P. B.; Tubbs, M. R. (Univ. of Warwick, Coventry, Eng.). Solid State Commun., 7: 397-9(Feb. 1969).

Color center concentrations exceeding $10^{19}/\mathrm{cm}^3$ were produced in KCl single crystals by irradiation with 5-keV electrons at energy deposition rates of 10^{20} $\mathrm{keV/cm^3/sec}$. The F-center concentration rose to a peak during irradiation and then decayed to a lower equilibrium value. Both this behavior and the annealing effects observed during intermittent irradiation can be explained by the formation of aggregate centers in the crystal. (auth) (UK)

23287 PARAMAGNETIC RESONANCE OF A HYDRAZINE-LIKE DEFECT IN IRRADIATED AMMONIUM CHLORIDE CRYSTALS. Marquardt, Charles L.; Patten, Frank W. (Naval Research Lab., Washington, D. C.). Solid State Commun., 7: 393-5 (Feb. 1969).

A radiation-induced paramagnetic defect center in ammonium chloride was characterized by hyperfine interaction with two nitrogen nuclei and four hydrogen nuclei. The nuclei were identified by observing the changes of the EPR spectra caused by isotopic substitutions. Previously, this EPR spectrum had been thought to be due to an electron trapped at a negative ion vacancy (F center). (auth) (UK)

23288 ESR STUDIES OF THE X-RAY-IRRADIATED NaCl–Fe SYSTEM. Nistor, S. V.; Darabont, A. (Univ. of Cluj). Solid State Commun., 7: 363-6(Feb. 1969).

NaCl single crystals were doped with $FeCl_3$ by slow diffusion. After x-ray irradiation, the samples exhibited complex ESR spectra, produced by increased paramagnetic centers. These spectra were analysed and the spin Hamiltonian constants were determined. (auth) (UK)

23289 THE IMPLANTATION PROFILES OF 10-, 20-, AND 40-keV ^{85}Kr IN GALLIUM ARSENIDE. Whitton, J. L. (Univ. of Salford, Eng.); Carter, G.; Freeman, J. H.; Gard, G. A. J. Mater. Sci., 4: 208-17(Mar. 1969).

The possibility of making semiconductor devices by implantation of impurity atoms requires a knowledge of the depth distribution or implantation profile of these atoms. The use of a micromechanical sectioning technique made such measurements possible over depths of as small as 30 Å. These measurements were made as a function of incident energy, crystallographic direction, and bombardment dose of radioactive krypton in single crystals of GaAs. It is concluded that ion implantation in GaAs is a viable process, that GaAs suffers ion bombardment induced damage at a relatively low dose, and that the energy and orientation dependence are similar to those seen previously in face-centered cubic materials. (auth) (UK)

23290 ELECTRONIC STRUCTURE OF TERBIUM USING THE RELATIVISTIC AUGMENTED-PLANE-WAVE METHOD. Jackson, C. (Imperial Coll. of Science and Tech., London). Phys. Rev., 178: 949-52(Feb. 15, 1969).

The energy bands for Tb have been calculated by the relativistic augmented-plane-wave method. The resulting Fermi surface is presented, and agreement is found with the characteristic wave vector describing the spiral phase of Tb. (auth)

23291 MULTILAYER ADSORPTION OF URANIUM ON TUNGSTEN. Collins, R. A.; Blott, B. H. (Univ. of Southampton, Eng.). Surface Sci., 13: 401-13(Feb. 1969).

The adsorption of uranium on tungsten field emitters has been studied for coverages of up to 12 monolayers for uranium deposited at 295°K and at pressures below 2×10^{-10} torr. A drop in work function from 3.60 to 3.38 eV was observed in the range 3 to 12 monolayers. This was attributed to growth of loose-packed α-uranium (100) faces on particular planes of the tungsten substrate. Further growth was observed on heating the deposit up to 900°K. Heating in the β-uranium temperature range (934 to 1042°K) resulted in a change in the regions in which preferred growth occurred. No evidence for nucleation in these regions was observed. Consideration of the surface topography revealed that the preferred growth regions correspond to surfaces on which the bulk uranium structure could be accommodated with only a small geometrical misfit. Mass spectrometric analyses of the evaporant flux from the evaporation sources were made, showing that the adsorbate contained no appreciable traces of W, UO, or UO_2 and further that the evaporation rate remained constant for the duration of the experimental measurements. (auth)

23292 PERIODIC VARIATIONS IN THE Z_1 DEPENDENCE OF INTERATOMIC POTENTIAL REVEALED BY A CHANNELING TECHNIQUE. Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 28A: 676-7(Feb. 24, 1969).

A channeling experiment that suggests a periodic variation in interatomic potential as a function of increasing atomic number is described. This variation is thought to result from periodic fluctuations in the radial distribution of electrons screening the Coulomb repulsion between two nuclei and is, therefore, dependent on impact parameter. (auth)

23293 RARE EARTH CONCENTRATION EFFECTS IN THE E. P. R. OF Gd IN $LaRu_2$ INTERMETALLIC COMPOUND. Davidov, D.; Lotem, H.; Shaltiel, D. (Hebrew Univ., Jerusalem). Phys. Lett., 28A: 672-3(Feb. 24, 1969).

The effect of Gd and Pr concentration on paramagnetic resonance of Gd in $LaRu_2$ was investigated both experimentally and theoretically. (auth)

23294 MAGNETIC HYPERFINE FIELD IN GADOLINIUM METAL. Zmora, H.; Blau, M.; Ofer, S. (Hebrew Univ., Jerusalem). Phys. Lett., 28A: 668-9(Feb. 24, 1969).

The perturbed angular correlation technique was employed for measuring the magnetic fields acting on the Gd and Lu nuclei in Gd_xLu_{1-x} alloys. From these measurements, the various contributions to the hyperfine field in Gd metal were determined. (auth)

23295 POSITRON ANNIHILATION IN METALS AND ALLOYS. Dekhtyar, I. Ya. (Inst. of Metal Physics, Kiev). Czech. J. Phys., 18: 1509-59(1968).

This review article summarizes the present knowledge of positron-annihilation research in metallic substances. Including a short historical survey, the annihilation processes in metals and alloys are discussed and various physical conditions such as ordering processes, magnetic phenomena, liquid state, superconductivity and lattice imperfections are considered. Finally, the present state of theoretical investigation is given and the outlook for the new and very useful technique in metal physics is pointed out. (auth)

23296 FIRST-ORDER PHASE TRANSITION IN EUROPIUM METAL. Cohen, R. L.; Huefner, S.; West, K. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Lett., 28A: 582-3(Jan. 27, 1969).

Moessbauer effect measurements of the hyperfine interaction in Eu metal were used to study the behavior of its sublattice magnetization in the vicinity of the magnetic transition temperature.

At $T = 88.5$°K the hf field falls from 0.4 of saturation to zero. This can be explained by the existence of a first-order transition coincident with the magnetic ordering. (auth)

23297 RESISTANCE MINIMA IN NONDILUTE Y–Ce ALLOYS. Hill, H. H.; Miner, W. N.; Elliott, R. O. (Los Alamos Scientific Lab., N. Mex.). Phys. Lett., 28A: 588-9(Jan. 27, 1969).

Resistance minima indicative of a spin-compensated state have been observed in hcp Y–Ce alloys containing up to 44 at. % Ce. (auth)

23298 ABSENCE OF INDUCED MAGNETIC FIELDS AT Gd NUCLEI IN GdFe$_2$. Maletta, H.; Frankel, R. B.; Henning, W.; Moessbauer, R. L. (Technische Hochschule, Munich). Phys. Lett., 28A: 557-8(Jan. 27, 1969).

Measurements of the magnetic hyperfine field at ^{155}Gd in GdFe$_2$ in external magnetic fields reveal the absence of induced magnetic fields, in disagreement with other reported data. (auth)

23299 ANNEALING BEHAVIOR OF P-TYPE LAYERS FORMED BY ION IMPLANTATION OF GALLIUM IN SILICON. Bulthuis, K.; Tree, R. (Mullard Research Labs., Surrey, Eng.). Phys. Lett., 28A: 558-60(Jan. 27, 1969).

The number of charge carriers in gallium implanted layers as a function of annealing temperature is related to the formation of neutral complexes. Corresponding differences in penetration depth of gallium atoms are noted. (auth)

23300 THE INFLUENCE OF CRYSTAL THICKNESS AND APERTURE ON THE TEMPERATURE DEPENDENCE OF THE ANOMALOUS ELECTRON TRANSMISSION IN GOLD FOILS. Boersch, H.; Just, T.; Niedrig, H. (Technische Univ., Berlin). Phys. Lett., 28A: 709-10(Feb. 24, 1969).

The temperature dependence of the anomalous electron transmission of polycrystalline gold foils was found to decrease for crystal thicknesses >1000 Å, and for measuring apertures exceeding a certain value, probably caused by incoherent diffuse scattering. (auth)

Theoretical Physics

23301 (ITF-68-79) METHOD OF NONEQUILIBRIUM STATISTICAL OPERATOR IN HOT ELECTRON THEORY. Kalashnikov, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 29p. (In Russian). (CONF-680949-2). Dep.

From 2nd Conference on Statistical and Physical Kinetics, Ukrainian, SSR.

A general scheme of hot electron theory based on the method of nonequilibrium operator built up on the basis of invariance of operator equations of motion is presented. The case of space-homogeneous spreadings of hot electrons in the crossed electric and magnetic fields interacting with equilibrium scatterers is considered. Equations of conservation of momentum and energies of the system in case of high concentrations of electrons are obtained (the algebraic equation system for macroscopic parameters) and in case of low concentrations (the system of differential equations of Fokker–Planck type in energy space). (auth)

23302 (ITF-68-81) ABOUT MINIMAX PRINCIPLE FOR SOME MODEL PROBLEMS OF STATISTICAL PHYSICS. Bogolubov, N. N. Jr. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 11p. (CONF-680949-1). Dep.

From 2nd Conference on Statistical and Physical Kinetics, Ukrainian, SSR.

A method for investigation of the model problems of general type containing at once the terms with positive and negative pair four-fermion interaction is proposed. An asymptotically exact solution for such problems under sufficiently general conditions is presented. The methodics under development led to minimax principle for the model problems with pair four-fermion interaction. (auth)

23303 (ITF-68-88) ABOUT DESCRIPTION OF QUANTUM-MECHANICAL SYSTEM IN CASE OF INCORRECTNESS OF SCHROEDINGER'S REPRESENTATION. Oleinik, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 20p. (In Russian). (CONF-680949-4). Dep.

From 2nd Conference on Statistical and Physical Kinetics, Ukrainian, SSR.

The description by means of Green's function method of the quantum-mechanical system for which Schrödinger's representation appears to be invalid is proposed. The pattern of the phase transition considered previously in electron gas in the field of an electromagnetic wave and homogeneous magnetic field is discussed. It is shown that relativistic and calibration invariances and the principle of microscopic causality being carried out; the relation of continuity for current is satisfied. The question about determination of probabilities of scattering processes is considered. The functional of unified probability is introduced by the help of which the probability of scattering of quanta of a coherent radiation on an electron in the homogeneous magnetic field is calculated. It should be noticed that the results obtained may be used to check the theory experimentally. (auth)

23304 (JINR-P2-4262) TIME MEASUREMENT IN STATIONARY QUANTUM MECHANICS. Zastavenko, L. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 18p. (In Russian). Dep.

A mathematical apparatus is suggested which allows one to obtain from the given stationary solution of the quantum-mechanical problem information on the time duration of the process determined by this solution. The apparatus suggested is practically an evident generalization of the one used, e.g., in explaining the rectilinear track produced by a particle in the Wilson chamber. (auth)

23305 (ORO-2408-11) QUANTUM THEORY OF MEASUREMENT. DeWitt, Bryce S. (North Carolina Univ., Chapel Hill). Jan. 1969. Contract AT(40-1)-2408. 32p. Dep. CFSTI.

The discussion of the quantum theory of measurement covers a review of the uncertainty relation, a space–time view of classical mechanics, the Stern–Gerlach experiment, electric field measurement according to Bohr and Rosenfeld, measurements of two observables, interpretations of quantum mechanics, and avoidance of the state vector of the Universe. (J.F.P.)

23306 STUDIES IN CONFIGURATION INTERACTION. III. GENERAL ANALYSIS OF THE TWO-BODY DENSITY FUNCTION. Cooper, Ian L. (Univ. of Manchester, Eng.). J. Chem. Phys., 50: 2166-75(Mar. 1, 1969).

Rules are presented for the determination of two-body transition density functions for pairs of spin-coupled functions corresponding to the same spin quantum numbers. The results are expressible in a number of alternative forms, in particular with respect to a basis of "Heitler–London-like" geminals. (auth)

23307 FUNDAMENTALS OF MEASUREMENT THEORY. Krips, H. P. (Univ. of Adelaide). Nuovo Cim., 60B: 278-90 (Apr. 11, 1969).

Two related problems are discussed which have arisen previously. The first concerns an extension to the interpretation given to density operator in Q.M.; and the second concerns the problem of the reduction of the wave packet in the theory of measurement. (auth)

23308 LINEAR MOMENTUM QUANTIZATION IN PERIODIC STRUCTURES. Van Vliet, K. M. (Univ. of Minnesota, Minneapolis). Physica, 35: 97-106(1967).

Interference by a periodic structure can be explained in terms of a quantization rule for the linear momentum formulated by Duane in 1923. A straightforward derivation of this rule, using raising and lowering operator techniques, is given both for one- and more-dimensional systems. The implications of these results for the conceptual exposition of quantum and wave mechanics are discussed. (auth)

23309 ON A STATEMENT OF THE PROBLEM AND AN ALGORITHM OF SOLUTION OF THE SCHROEDINGER EQUATION BY THE MONTE CARLO METHOD. Dyad'kin, I. G.; Zhukova, S. A. Zh. Vychisl. Mat. i Mat. Fiz., 8: 222-9(1968). (In Russian).

A statement of the Schroedinger equation problem and an algorithm for solving the problem through the use of the Monte-Carlo method are presented. It is desired to determine the base level of energy of a microsystem consisting of n particles. The Monte-Carlo method is applied to the solution of the energy equation expressed in the integral equation form proposed by R. Feynman. The authors demonstrate the modeling of randomly generated values and give a numerical evaluation of the feasibility of the proposed means of solution. (ATD) (TSS)

23310 GENERAL FORMULATION OF THE VECTOR FIELD EQUATIONS. Murzagaliev, G. Zh. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 142-3(1968). (In Russian).

Principle vector field equations are universally developed on the basis of four-dimensional vector potentials. An attempt is made here of developing such equations on the basis of variational principles, taking into account the second-rank antisymmetric tensor which is its single-term energy characteristic. (R.V.J.)

23311 TIME EVOLUTION OF A SYSTEM WITH A STOCHASTIC HAMILTONIAN AND A GIVEN INITIAL STATE. Czajkowski, G. Z. (Univ. of Torun, Poland). Acta Phys. Pol., 35: 145-60(Jan. 1969).

The time evolution of a quantum system, which with a given Hamiltonian and an initial state is described by the Von Neumann equation, is discussed in the case of a stochastic Hamiltonian. The notion of a stochastic Hamiltonian is taken from the statistical theory of the energy levels of complex systems. Following the ideas of Ingarden (1965, independently also Porter 1965, Bronk 1966), the conventional statistical approach used in the statistical theory of energy levels is generalized by means of the variational principle of information thermodynamics. The optimum density operator is introduced and its matrix elements are calculated in some special cases. The reversibility of the evolution of the system described by the optimum density operator is discussed. It is shown that in the cases considered this evolution is irreversible. (auth)

23312 A MODEL FUNCTION FOR THE SELF-ENERGY OPERATOR IN AN INFINITE SYSTEM. Bolterauer, Hannes (Justus Leibig Univ., Giessen, Ger.). Z. Phys., 220: 265-72 (1969). (In German).

The most simple rational model function for the self-energy operator exhibiting the properties which are demanded by the general theory of infinite Fermi systems for the asymptotic region and the neighborhood of the Fermi surface is considered. The occupation number which may be calculated exactly is determined for various parameters. (auth)

23313 DETERMINATION OF THE CONSTANT h/2e (THE MAGNETIC FLUX QUANTUM). Gorbatsevich, S. V.; Zalutskaya, T. L. Izmer. Tekh., No. 2, 47-9(Feb. 1969). (In Russian).

Properties of magnetic flux related to super conducting solids and the Josephson tunnel effect were investigated. The value obtained for the magnetic flux quantum was $h/2e = 2.06786 \cdot 10^{-15}$ weber. (R.V.J.)

23314 ALTERNATIVE METHOD FOR EXACT DIAGONALIZATION OF THE HAMILTONIAN DESCRIBING A TWO-LEVEL SYSTEM COUPLED TO A BOSE GAS WITH AN EINSTEIN SPECTRUM. Nickle, H. H. (Duke Univ., Durham, N. C.). Phys. Kondens. Mater., 8: 279-83(1969).

A simple method is described which exactly diagonalizes the Hamiltonian describing a two-level system coupled to a Bose gas with an Einstein spectrum. The method is based on a separation of the boson field into two mutually orthogonal (and commuting) parts, one of which corresponds to the bound spectrum, the other corresponds to the continuous spectrum. It is also shown that such an additive, linear, field-splitting method is inadequate for the case of a nonconstant spectrum. (auth)

23315 ATOMIC INTEGRALS CONTAINING r_{ij}^p CORRELATION FACTORS WITH UNLINKED INDICES. Perkins, J. F. (Army Missile Command, Redstone Arsenal, Ala.). J. Chem. Phys., 50: 2819-23(Apr. 1, 1969).

The S states of multielectron atoms can be calculated by use of Rayleigh–Ritz expansions, each term of which is a product of Slater-type functions, $r_i^n \exp(-\alpha r_i)$, and a single two-electron correlation factor of the form r_{ij}^p. This requires convenient (preferably algebraic, rather than numerical integration) methods for evaluating the five types of energy and normalization integrals that arise. Formulas for some of these integrals, including the relatively difficult linked-index three-electron integral, have been given previously. For each of the four nonlinked-index integrals, there is given herein an explicit, computer-programmable formula in which the expansion parameters are treated as input arguments. Practicality of the formulas was demonstrated by preparation of a FORTRAN computer program that was used to evaluate sample integrals. Some differencing error is involved, but typically results in loss of only two or three significant figures. (auth)

23316 ADVANCES IN THEORETICAL PHYSICS. VOLUME 2. Brueckner, Keith A. (ed.). New York, Academic Press Inc., 1968. 184p. $12.00.

Papers on unitary symmetry and correlation structure in atoms are included. A separate abstract was prepared for each paper. (A.G.W.)

For abstracts of individual papers see: 22918 and 23511.

23317 STATISTICAL MECHANICS IN EXTERNAL FORCE FIELDS. Derrick, G. H. (Univ. of St. Andrews, Fife, Scotland). Phys. Rev., 181: 457-62(May 5, 1969).

A theory is developed for the statistical mechanics of a system of interacting particles contained by an external potential instead of by a box. Most attention is paid to the special case of particles in a three-dimensional harmonic oscillator potential $V(r) = \beta^{-1}\pi r^2/L^2$, where the parameter L is a length of macroscopic dimensions which is ultimately allowed to increase indefinitely while keeping the density of particles at the origin finite. As an application of the formalism, an expression is obtained for the surface tension between a liquid and its vapor in equilibrium. (auth)

23318 THEORY OF ELECTRON DIFFUSION PARALLEL TO ELECTRIC FIELDS. I. THEORY. Parker, James H. Jr.; Lowke, John J. (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 181: 290-301(May 5, 1969).

Recent experimental results in many gases demonstrate that the apparent rate of electron diffusion parallel to an electric field can differ significantly from that in the perpendicular direction. This anomalous behavior was explained by taking account of the effect of electron density gradients on the solution of the Boltzmann equation representing a pulse of electrons under the influence of a uniform electric field. When the electron collision frequency increases with energy, the theory predicts that the leading edge of the pulse has a reduced mobility because of a higher-average electron speed and collision rate. Similarly the mobility of the trailing edge is enhanced, and consequently the half width of the pulse in the field direction is characterized by a new diffusion coefficient. The ratio of the longitudinal diffusion coefficient to the transverse diffusion coefficient is given as integrals involving the momentum transfer cross section and the unperturbed energy distribution. This ratio at high electric fields is found to be approximately one-half and one-fifth, for momentum transfer cross sections that are independent of and linearly proportional to the electron energy. (auth)

23319 THEORY OF ELECTRON DIFFUSION PARALLEL TO ELECTRIC FIELDS. II. APPLICATION TO REAL GASES. Lowke, John J.; Parker, James H. Jr. (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 181: 302-11(May 5, 1969).

The theoretical analysis of the preceding paper is extended to include inelastic collisions. The resulting theory is then used to obtain values for the diffusion coefficient D_L, which is appropriate for electrons diffusing parallel to an electric field. Theoretical values of D_L/μ are compared with values of D_T/μ as a function of E/N for the gases helium, argon, hydrogen, deuterium, nitrogen, oxygen, carbon dioxide, water vapor, carbon monoxide, krypton, and xenon; μ is the electron mobility, D_T is the diffusion coefficient for electron diffusion perpendicular to the electric field, E is the electric field strength, and N the number density of the gas. A comparison is also made between theoretical values of D_L/μ and the available experimental values of this quantity. Experimental differences that have been observed between D_L and D_T of the order of a factor of seven in argon and a factor of two in helium, hydrogen, and nitrogen are satisfactorily explained. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

23320 THE ROLE OF PURE SCIENCE IN EUROPEAN CIVILIZATION. Powell, C. F. (Univ. of Bristol, Eng.). pp 262-71 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

A discussion is presented on the rapid advance of science and international collaboration in science, the progress of high-energy physics, the significance of recent advances, the needs of pure science, and the material benefits from it. The importance of balanced development of science and technology, and pure science as an indispensable element in our culture are also covered. (J.F.P.)

23321 REMARKS ON SOME TECHNICAL AND ORGANIZATIONAL PROBLEMS OF ELEMENTARY-PARTICLE PHYSICS. Pickavance, T. G. (Rutherford High-Energy Lab., Didcot, Eng.). pp 240-50 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

Problems of organization for high-energy physics research are described. These problems include the need for substantial and growing supplies of money, and the sophistication of experimental techniques. The problem of scale, the basic unit of which is a single high-energy accelerator surrounded by its operating and supporting technology and manned by its research teams, is also considered. Lastly the problem of ensuring the proper intellectual environment is discussed. This environment is considered to be a university. (J.F.P.)

23322 PROCEEDINGS OF HIGH ENERGY PHYSICS MEETING, PISA, ITALY, OCTOBER 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967. 299p. (In English and French). (CONF-671079).

Seventeen papers are presented on experimental and theoretical topics in high-energy physics. A separate abstract was prepared for each paper. (L.B.S.)

For abstracts of individual papers see: 23334, 23335, 23338, 23339, 23353, 23356, 23374–23377, 23421–23423, 23478, 23564, 23593, and 23594.

23323 SEARCH FOR QUARKS. Fukushima, Y.; Kifune, T.; Kondo, T.; Moshiba, M.; Naruse, Y.; Nishikawa, T.; Orito, S.; Suda, T.; Tsunemoto, K.; Kimura, Y. (Tokyo Univ.). Phys. Rev., 178: 2058-60(Feb. 25, 1969).

A search was made for fractionally charged particles (quarks) in cosmic rays at sea level. The detection system consists of twelve layers of scintillation counters and a streamer chamber with an overall acceptance of 0.20×10^4 cm^2 sr. Particles of charges $\frac{1}{3}$e and $\frac{2}{3}$e were identified by their characteristic energy losses in each of the twelve counters as well as by a single straight track in the streamer chamber. Coincidences of many low-energy photons are responsible for the background events, as is shown by features of the particle tracks in the streamer chamber and by the fluctuation of the flight time in the counter array. In selecting quarks from the backgrounds, the observed events were checked by: (i) a test for correlation among the individual pulse heights; (ii) a test for the arrival time correlation; (iii) the requirement of a single straight track in the streamer chamber which could penetrate the whole counter system if extrapolated. During a total of 3500 h of operation, there was one event for $\frac{1}{3}$e charge and none for $\frac{2}{3}$e charge which satisfied the above requirements. This one event occurred when the chamber was not yet in operation. The upper limits obtained on the flux of relativistic quarks in cosmic rays at sea level are 0.5×10^{-10} cm^{-2} sr^{-1} sec^{-1} for $\frac{1}{3}$e, and 7.5×10^{-10} cm^{-2} sr^{-1} sec^{-1} for $\frac{2}{3}$e. (auth)

Electromagnetic

Refer also to abstracts 23376, 23405, and 23627.

23324 (LNF-69/3) PHOTOPRODUCTION OF π^0 BY POLARIZED GAMMA RAYS. Note No. 426. Barbiellini, G.; Bologna, G.; Capon, G.; De Wire, J.; De Zorzi, G.; Diambrini, G.; Fabbri, F. L.; Murtas, G. P.; Sette, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Jan. 8, 1969. 24p. Dep.

The asymmetry of the cross section from polarized photons for π^0 photoproduction on hydrogen was measured using the coherent bremsstrahlung beam from a diamond. The asymmetry was measured at a proton angle of 90° in the cms system for photon energies of 230 to 380 MeV. (J.F.P.)

23325 (LNF-69/7) REMARKS ON A POSSIBLE DIRECT PRODUCTION OF MUONS. Note No. 430. Etim, E.; Picchi, P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Jan. 28, 1969. 9p. Dep.

A survey of experimental data is given which cannot be accommodated in a model of direct meson (μ) production with the photonuclear cross section increasing with the transferred energy. (J.F.P.)

23326 (ORNL-tr-1892) EXPERIMENTAL STUDIES OF ELECTRON–PHOTON CASCADES IN LEAD-SCINTILLATOR SYSTEMS FOR PRIMARY ENERGIES BETWEEN 100 AND 440 MeV. Beuermann, Klaus-Peter; Wibberenz, Gerd. Translated for Oak Ridge National Lab., Tenn., from Z. Phys., 206: 247-65(1967). 22p. Dep. CFSTI.

Showers generated by electrons of 200 and 440 MeV energy in single lead plates of 2, 5, and 10 radiation lengths are measured in scintillator material (NE 102 A) varying between 1.24 and 10.5 g/cm^2. The mean energy deposited in a scintillator is derived from Nagel's Monte-Carlo calculations. The photon contribution n_γ to the total pulseheight is of the order 15% near shower maximum t_{max} it dominates the electron contribution n_e in a 3 cm thick scintillator for shower depths $t \geqq 4.2 \cdot t_{max}$. The slope of the total ionization $n_e + n_\gamma$ behind the shower maximum can be approximated by $n(t) \sim \exp(-0.264\ t)$. The shower absorption in scintillator depends on the thickness x (g/cm^2) as $\exp(-0.068\ x)$. An arrangement of counter trays, scintillators and lead plates is calibrated with electrons between 100 and 440 MeV energy. A suitably defined track-length S is shown to give minimum error in energy measurement and to depend linearly on electron energy. The track-length constant of 22 MeV/r.l. is compared with previous results. (auth)

23327 PROTON COMPTON EFFECT. Baranov, P. S.; Fil'kov, L. V.; Sokol, G. A. (Lebedev Inst. of Physics, Moscow). Fortschr. Phys., 16: 595-634(1968).

A method of calculating cross sections of Compton scattering on protons based on dispersion relations at a fixed square of the momentum transferred with a subtraction for invariant amplitudes is thoroughly discussed. Dispersion sum rules for the interaction constants of π^0, η, and X^0 mesons are analyzed. A comparison is made by means of χ^2-test. The results obtained from the comparison of the experimental data in the range of energies up to 300 MeV with the theoretical cross sections are presented. In the range of gamma-ray energies from 180 to 220 MeV a strong difference between theoretical calculations and experimental data is observed. In the other ranges of energy the experimental data available are in agreement with the theoretical calculations, the contribution from the annihilation channel being considered and the sign of the contribution from the π^0-meson pole being chosen equal to the sign of the main amplitude. (auth)

23328 RESULTS AND PROGRAMS IN THE SEARCH FOR FRACTIONARY CHARGES BY THE MAGNETIC LEVITATION ELECTROMETER. Morpurgo, G. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). pp 222-39 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

Possible methods of searching for quarks are described. For this purpose the magnetic levitation electrometer is developed. A short summary of the results obtained thus far with this instrument is presented. (J.F.P.)

23329 FUTURE OF NEUTRINO PHYSICS WITH LARGE CHAMBERS. Lagarrigue, A. (Faculte des Sciences, Orsay, France). pp 141-55 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

From the discussion of neutrino physics with giant bubble chambers it is concluded that the technical facilities needed to perform neutrino experiments are already greatly improved but will be further developed with the large new accelerators. The one-event-per-picture rate will thus be achieved in the large hydrogen bubble chambers. (J.F.P.)

23330 SOME RECENT EXPERIMENTS AT DESY. Jentschke, W. (Deutsches Elektronen-Synchrotron, Hamburg).

pp 120–40 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

Some experimental results obtained at the 6-GeV electron accelerator in Hamburg are presented. These experiments include photoproduction of wide-angle electron–positron pairs at high energies, electromagnetic form factors of the proton, and photoproduction of vector mesons and the η resonance. (J.F.P.)

23331 MUON SHOWERS DEEP UNDERGROUND. Porter, Lee Grant. Salt Lake City, Univ. of Utah, 1968. 153p.
Thesis.

Data gathered during a preliminary test of a part of the University of Utah underground neutrino detector is used in a study of showers of high energy muons at zenith angles from 30 to 75° and depths from 1500 to 5000 hg cm^{-2}. The parallelism of muon pairs in the showers is measured and indicates that the muons are part of the penetrating component in cosmic ray air showers. A characteristic width for the lateral distribution of the muons in the showers is obtained from a study of the number of muon pairs vs their spatial separation (decoherence curve). An empirical shower density spectrum is derived by fitting a multi-parameter density function to the data for single, double and triple muon events. No unique set of parameters is found, but fits to the data at all depths and zenith angles are obtained. The arrival directions of more than 2000 underground muon showers containing two or more muons are plotted in right ascension. No anisotropy is observed. (Disser. Abstr.)

23332 PHOTOPRODUCTION OF ETA MESONS FROM HYDROGEN AT PHOTON ENERGIES BETWEEN 0.8 AND 1.45 GeV. Rochester, Leon S. Pasedena, Calif., California Inst. of Tech., 1968. 140p.
Thesis.

The differential cross section of the process $\gamma p \rightarrow p\eta$ was measured at the 1.5-GeV Caltech electron synchrotron, at photon energies from 0.8 to 1.45 GeV, at various angles between 45 and 100° in the center of mass. A counter-spark chamber array was used to determine the kinematics of all particles in the final state of the partial mode $\gamma p \rightarrow p\eta$ $(\eta \rightarrow 2\gamma)$. Analysis of 40,000 pictures yielded 6,000 events above a background which varied with energy from 5% to 30% of foreground. The cross section shows an energy dependence confirming earlier results up to 1000 MeV, but with improved statistics; it then remains roughly constant (at 50° C.M.), to 1.45 GeV. The data show a small angular variation, within the limited range covered, at energies between 1000 and 1100 MeV. (Disser. Abstr.)

23333 PHOTOPRODUCTION OF η MESON BETWEEN THRESHOLD AND 900 MeV. Delcourt, B. (Ecole Normale Superieure, Orsay, France); Lefrancois, J.; Perez-Y-Jorba, J. P.; Sauvage, G.; Mennessier, G. Phys. Lett., 29B: 75-8 (Mar. 31, 1969).

Differential cross sections of $\gamma + p \rightarrow p + \eta^0$ were measured at several energies. The angular distributions show that S_{11} production is predominant in the energy range investigated and that the other resonant terms seen in π-production of η are absent or very low. Finally, experimental data are theoretically interpreted and the S_{11} parameters deduced. (auth)

23334 THE EXPERIMENTAL SITUATION ON THE BRANCHING RATIO OF THE η-PARTICLE. Silvestrini, V. (CNEN, Frascati, Italy). pp 72-83 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.), Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica 1967.
See CONF-671079.

The present experimental situation on the branching ratios of the η decays is summarized according to the method used. A brief analysis is given of each of the four groups. (L.B.S.)

23335 EXTENSION OF THE γ-γ COINCIDENCE METHOD TO STUDY $\pi^0 + \gamma$ DECAYS. pp 64-71 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.
See CONF-671079.

The $\gamma\gamma$ coincidence method used to search for the 2γ decay of the X^0 meson is shown to be effective for detecting resonances which decay into $\pi^0 + \gamma$. The method was applied at DESY to measure the cross section for ω photoproduction in complex nuclei. Preliminary results are shown. (L.B.S.)

23336 FORMATION OF THE $Y_1^*(1616)$ AND $Y_1^*(1700)$ IN K_L^0p INTERACTIONS. Blumenfeld, B. J.; Kalbfleisch, G. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 29B: 58-61 (Mar. 31, 1969).

The recently discovered $Y_1^*(1616)$ and $Y_1^*(1700)$ resonances were observed in the formation reactions $K_L^0p \rightarrow \Lambda\pi^+$ and $K_L^0p \rightarrow \Lambda\pi^+\pi^0$. The mass values observed are in agreement with previous experiments but the widths are narrower. (auth)

23337 PHOTOPRODUCTION OF K^0-MESONS. Albrow, M. G. (Univ. of Manchester, Eng.); Aston, D.; Barber, D. P.; (and others). Phys. Lett., 29B: 54-7(Mar. 31, 1969).

The photoproduction of K_L^0-mesons from protons was studied at an angle of $3\frac{1}{2}$° and for photon energies up to 5 GeV. The cross section for production of K_L^0-mesons with momenta above 1.5 GeV/c rises to 14 μb/sr/equivalent quantum at a bremsstrahlung peak energy of 5 GeV. (auth)

23338 EXPERIMENTAL DETERMINATION OF THE η AND π^0 LIFETIMES BY THE MEASUREMENT OF THE PRIMAKOFF EFFECT. Bemporad, C. (Univ., Pisa, Italy. Istuto Nazionale di Fisica Nucleare, Pisa, Italy); Braccini, P. L.; Foa, L.; Luebelsmeyer, K.; Schmitz, D. pp 53-63 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.
See CONF-671079.

The angular distributions of η and π^0 photoproduction on zinc, silver, and lead were studied at 4.0 and 5.5 GeV and at 1.5 and 2 GeV, respectively. From measurements of the Primakoff effect, the η and π^0 lifetimes were determined. (L.B.S.)

23339 EXPERIMENTAL STUDY OF THE DECAY MODES OF THE η MESON. Bunyatov, S. (CERN, Geneva); Zavattini, E.; Deinet, W.; Mueller, H.; Schmitt, D.; Staudenmaier, H. pp 96-107 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.
See CONF-671079.

The decay of the η meson into 2γ, $\pi^0 + \gamma + \gamma$, and π^0 was studied from the $\pi^- + p \rightarrow \eta + n$ interaction at 763 MeV/c, using a neutron missing-mass spectrometer combined with optical thick-plate spark chambers. From Monte Carlo calculations of the detection probability the branching ratios were determined. (L.B.S.)

23340 ASYMMETRIC ELECTRON PAIR PRODUCTION ON CARBON. Simonds, Robert Merle. Stanford, Calif., Stanford Univ., 1968. 156p.
Thesis.

The reaction $\gamma + C \rightarrow e^+ + e^- + C$ was studied by several investigators as a means of verifying the high energy predictions of quantum electrodynamics (QED). "Symmetric" wide angle pair experiments detect both electron and positron at equal momenta and equal angles with respect to the incident photon direction; momentum transfer to the target nucleus is small, and the interference term between Bethe-Heitler and Compton pair production amplitudes vanishes with proper experimental procedures. The "asymmetric" experiment detects only one member of the pair; target nuclear momentum transfer is relatively large, and the effects of nuclear structure as well as the interference terms become significant. A measurement is made of the asymmetric cross section for production of single electrons or positrons by photons in the energy range of the first and second pion-nucleon resonances. The experiment was designed to provide another verification of the predictions of the point interaction hypothesis of QED and a first measurement of possible charge asymmetry expected from interference processes in the region of the first and second resonances. (TSS) (Diss Abstr.)

Weak

23341 SEARCH FOR $\Delta Q = -\Delta S$ TRANSITIONS IN Σ-HYPERON DECAYS. Eisele, F.; Engelmann, R.; Filthuth, H.; (and others) (Univ., Heidelberg). Z. Phys., 221: 401-10(1969).

In the sample of 10^6 Σ^+ hyperons the decays $\Sigma^+ \rightarrow ne^+\nu$ and $\Sigma^+ \rightarrow n\mu^+\nu$, which would violate the $\Delta Q = \Delta S$ rule were searched for. No $\Sigma^+ \rightarrow ne^+\nu$ decay was found, whereas 313 $\Sigma^- \rightarrow ne^-\nu$ decays were identified in the same film. With 90% confidence we obtain $[\Gamma(\Sigma^+ \rightarrow ne^+\nu)/\Gamma(\Sigma^- \rightarrow ne^-\overline{\nu})] \leq 3 \cdot 10^{-2}$. Having found two candidates for the decay $\Sigma^+ \rightarrow n\mu^+\nu$ and 104 $\Sigma^- \rightarrow n\mu^-\overline{\nu}$ events for the muonic mode $[\Gamma(\Sigma^+ \rightarrow n\mu^+\nu)/\Gamma(\Sigma^- \rightarrow n\mu^-\overline{\nu})] \approx 0.06$ is obtained. The probability that the μ^+-events are simulated by $\Sigma^+ \rightarrow n\pi^+\gamma$ with subsequent undetected $\pi^+ \rightarrow \mu^+\nu$ decay is less than 4%. (auth)

23342 THE π^+ MESONIC DECAYS OF LIGHT HYPERNUCLEI. Bohm, G. (Forschungsstelle fuer Physik Hoher Energien, Berlin); Klabuhn, J.; Krecker, U.; (and others). Nucl. Phys., B9: 1–9 (1969).

Twenty examples of π^+ mesonic decays of light hypernuclei were found together with 7000 π^- mesonic decays. The ratio R_4 of π^+

mesonic decays for the ${}_{\Lambda}He^4$ hypernucleus was computed from the results of this work and those of a previous experiment and is found to lie between the values $5.4 \pm {}^{1.5}_{1.7}\%$ and $6.9 \pm {}^{1.8}_{2.1}\%$. The π^+ mesonic decays of other species of hypernuclei are briefly discussed. (auth)

23343 NEUTRINO EXPERIMENTS AND THE QUESTION OF LEPTONIC-CHARGE CONSERVATION. Pontecorvo, B. (Joint Inst. of Nuclear Research, Dubna, USSR). pp 251-61 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

Neutrino experiments demonstrating leptonic charge conservation are reviewed. This review covers selection rules, leptonic charge violation, double beta decay, $\nu + p \rightarrow e^+ + n$, $\mu \rightarrow e + \gamma$, and $\mu^- + Z \rightarrow e + (Z - 2)$ processes, possible oscillations $\nu \rightleftharpoons \bar{\nu}$ and $\nu_\mu \rightleftharpoons \nu_e$ in vacuum. Also included are methods of observing neutrino oscillations, period and length of oscillations, and oscillations $\nu \rightleftharpoons \bar{\nu}$ in astronomy. (J.F.P.)

23344 THE PHASE DIFFERENCE BETWEEN $K_L \rightarrow \pi^+\pi^-$ AND $K_S \rightarrow \pi^+\pi^-$ DECAY AMPLITUDES. Boehm, A.; Darriulat, P.; Grosso, C.; Kaftanov, V.; Kleinknecht, K.; Lynch, H. L.; Rubbia, C.; Ticho, H.; Tittel, K. (CERN, Geneva). Nucl. Phys., B9: 605-39 (1969).

The phase difference between the $K_L \rightarrow \pi^+\pi^-$ and $K_S \rightarrow \pi^+\pi^-$ decay amplitudes was measured by observing the time dependence of the $\pi^+\pi^-$ decay intensity from an initial K^0 (strangeness = +1) state. The phase difference $\phi_\pm$ is found to be 41° ± 12° for a $K_L - K_S$ mass difference $\Delta m/\hbar = 0.526 \times 10^{10}$ sec^{-1}. The error includes statistical and systematic uncertainties. The phase $\phi_\pm$ is strongly correlated to the value adopted for $\Delta m/\hbar$. The present uncertainty on $\Delta m/\hbar$ increases our error on $\phi_\pm$ from 12° to 15°. The result is in agreement with the prediction of the "superweak model" of CP violation. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 22094 and 23595.

23345 FRAGMENTATION OF COSMIC NUCLEI WITHOUT PARTICLE FORMATION AT 10 TO 1000 GeV NUCLEON ENERGY. Rybitski, K. (Inst. for Nuclear Research, Krakow). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 390-1(1968). (In Russian).

Descriptions are given of super-high energy nuclei interactions or nuclear spallation not related to particle formation. The selection criterion was as follows: $n_s = Z_p - Z_s - 2n_\alpha$; $\sqrt{\langle\theta^2\rangle} = 0.12/E$ (GeV) (so called Kaplon formula for proton fragmentation angles) where n_s is the number of tracks of relativistic singly charged particles, Z_p and Z_s. The charge of the primary and secondary nuclei, N_α is the number of relativistic α particles from the spallation of primary nuclei, and θ is the angle of relativistic particle emission. The selected particles were relativistic singly charged protons and were studied in two photoemulsion layers. The ratio of electromagnetic spallations in relation to all nuclear interactions were determined. The probability of photospallation in Coulomb field of light nuclei was nearly two orders smaller. Consequently the events with $n_h > 0$ (collisions with light nuclei) are related to strong interactions (as for example elastic nucleon—nucleon scattering followed by spallation of both nuclei). The results of the work showed spallation of relativistic cosmic radiation without generation of particles, mostly events of $n_h = 0$. These events are in good agreement with the assumption on photospallation of primary nuclei by photons from Coulomb fields of heavy nuclei in the photoemulsion. The rest of the events were related to strong interactions with light nuclei. (R.V.J.)

23346 AN ATTEMPT OF DETERMINING ELASTIC PROTON–NUCLEON CROSS SECTION AT ENERGIES ABOVE 10^{12}eV. Rybitski, K. (Inst. of Nuclear Research, Krakow). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 385-6(1968). (In Russian).

Photoemulsion layers were irradiated at high elevation, and initial superhigh energy showers over 10^{12} eV were examined in order to determine elastic proton—nucleon cross sections. Examination of 5.38 m of proton tracks revealed three cases of the anticipated type. Gray proton tracks with energies of 35 and 60 MeV and at angles of 59.5 and 56.6° to the initial direction were observed in two cases, and a star with black and gray tracks with total $\lambda = 11.32$ m/3 = (3.78 ± 2.07)m. Control experiment with three 24 GeV proton tracks resulted in $\lambda = 23.4$ m/11 = (2.13 ± 0.64) m. Thus, it was shown that at energies of several TeV the total cross section of proton—nucleon elastic scattering coincide with the cross section at 24 GeV. Converting of the length of interactions in the photoemulsion to the proton—nucleon cross section, roughly, $\sigma_{elastic} = 3.8^{+12.7}_{-1.3}$ m barns was obtained. (R.V.J.)

23347 ENERGY OF NUCLEAR ACTIVE PARTICLES IN WIDE ATMOSPHERIC SHOWERS RECORDED BY A LARGE IONIZATION CALORIMETER. Babayan, Kh. P.; Boyadzhyan, N. G.; Grigorov, N. L.; Nymmik, R. A.; Shestoperov, V. Ya. (Moscow State Univ. Inst. of Physics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 405-8(1968). (In Russian).

One hundred and ninety two events of atmospheric showers with number of particles $n_s \geq 1.4 \times 10^5$ were recorded (with the probability of 100%) by a large (10 m^2 effective volume) ionization calorimeter. Data obtained for 192 showers were averaged for determining the distribution of ionization on the depth calorimeter. The absolute magnitudes of nuclear-active component energy in the wide atmospheric showers were compared with published data. The tabulated results showed that the energy of nuclear active components measured with an ionization calorimeter was considerably smaller than that obtained by ionization impact measurements. The ratio of nuclear-active energy flux and electron—photon component in wide atmosphere shower of various radii also confirmed that the nuclear-active component flux is considerably smaller than the magnitude quoted by others. (R.V.J.)

23348 ABSORPTION OF NUCLEAR COMPONENT ENERGY FLUX IN A CALORIMETER. Grigorov, N. L.; Shestoperov, V. Ya.; Sobinyakov, V. A.; Tret'yakova, Ch. A. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 403-4(1968). (In Russian).

Absorption of nuclear component energy flux in iron was studied using a 10 m^2 and ~700 g·cm^2 thick ionization calorimeter. The device operated with three radiotechnical thresholds: 5.3×10^{11}, 7.6×10^{11}, and 1.5×10^{12} eV. Absorption of nuclear component energy flux in recorded 83 events began at thickness of 400 to 500 g·cm^{-2} and followed the law with absorption coefficient K = 1/L, where L is the mean free path. Curves are given for the energy flux absorption at initial particle energy from 10^{12} to 1.5×10^{12} eV calorimeter threshold 5.3×10^{11} and 7.6×10^{11} eV and at nuclear component energy in the range from (1.5 to 3.0) × 10^{12} eV at radio technical threshold 5.3×10^{11} and 1.5×10^{12} eV showed that the further the energy range of the recorded initial particles from radiotechnical threshold the more the absorption of nuclear component energy flux changed, approaching the law of $K_{absorp.} = 1/3$ L independent from the energy of the initial particles. (R.V.J.)

23349 MEAN FREE PATH OF NUCLEAR-ACTIVE PARTICLE INTERACTIONS IN IRON AT ENERGIES ≥5.3×10^{11} eV. Grigorov, N. L.; Shestoperov, V. Ya.; Sobinyakov, V. A.; Tret'yakova, Ch. A. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 401-2(1968). (In Russian).

A seven series ionization calorimeter was used for determining the mean free path of nuclear-active particle interactions in iron considering the number of interactions in layers of identical thickness. A device recorded the interactions with $E \geq 5.3 \times 10^{11}$ eV. Events of single interactions of nuclear-active particles in iron filters were selected for studies. The mean path of particle interactions, after taking into account the angular distribution of the recorded particles, was equal to 133 ± 14 g/cm^{-2} which in good agreement with published data. (R.V.J.)

23350 CROSS SECTION OF INELASTIC INTERACTIONS OF NUCLEAR-ACTIVE PARTICLES WITH NUCLEI OF IRON AND LEAD ATOMS IN THE ENERGY RANGE FROM 100 TO 1000 GeV. Denisov, E. V. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 398-400(1968). (In Russian).

Data obtained on cross sections of nuclear-active particle interactions with nuclei of iron and lead atoms up to 1000 GeV were used for determining the index of cross section as function of the atomic number. With the function written out as $\sigma = \sigma_0 A^\alpha$, where the $\alpha = 0.67 \pm 0.06$ the prediction of the theory of complex orbital moments on the linear dependence of cross section on A did not hold either due to the insufficiently high initial energies or due to the error in the theoretical prediction. (R.V.J.)

23351 CROSS SECTIONS OF INELASTIC INTERACTIONS OF NUCLEAR-ACTIVE PARTICLES IN CARBON AND IRON IN ENERGY RANGE FROM 7 x 10^{10} TO 10^{12}eV. Andronikashvili, E. L.; Gabuniya, L. L.; Garibashvili, D. I.; (and others). (Inst. of Physics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 396-7(1968). (In Russian).

Cross sections of nuclear-active particle interactions on carbon and iron were measured with a Tskhra-Tskaro installation (design is included). A carbon target was placed over the lower chamber and the cross section of carbon was determined as a relation of the number of particles interacting in the target and the total number of particles passing through the target. Calorimetric data were used for determining the direction of passing nuclear-active particles. The experiment treated at least two series in each projection of ionizing calorimeter with total energy of >70 GeV. The cross section of inelastic interactions of nuclear-active particles in iron was measured using the data obtained with ionizing calorimeter. Graphical data are given of the cross section as a function of energy. Within the limits of statistical data the cross section remains unchanged. (R.V.J.)

23352 STUDIES OF ANGULAR DISTRIBUTION OF PENETRATING PARTICLES FORMED DURING NUCLEAR INTERACTIONS BETWEEN COSMIC RAYS AND A SOLID. Apshev, S. Zh.; Sakvarelidze, I. I. (Tbilisi State Univ., USSR. Kabardino-Balkarian State Univ., Nalchik, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 392-3(1968). (In Russian).

Angular distribution of shower penetrating particles formed during cosmic ray interaction with carbon, lead, copper, and tin nuclei was studied assuming that the predominant number of particles are pions with some heavier particles (hyperons and K mesons). Results of studies carried out at 1800 m elevation with 118 showers formed in a generator (1.2 cm thick) placed between two Wilson chambers are given in graphical form. The measurements were made for a primary particle with energy up to 6 GeV. Construction of angular distribution of shower particles in c.m.s. (25 events) produced isotropic angular distribution. At higher energies (E > 100 GeV) it should be possible to observe the anisotropy in secondary shower particle, in the c.m.s. (R.V.J.)

23353 $\bar{p}n$ ANNIHILATION AT REST INTO K $\bar{K}\pi$. Bertanza, L. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy); Bigi, A.; Carrara, R.; (and others). pp 137-41 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.

See CONF-671079.

Experimental details are reported of a preliminary study of $\bar{p} + d \rightarrow K + K + \pi + p$ channels, where the annihilation is assumed to be on the neutron of the deuterium. Effective mass distributions are presented for the π^0K, K^-K_1, π^-K, and K_1K^0 channels. (L.B.S.)

23354 STRUCTURE IN THE K$\overline{K}$ DECAY MODE OF THE A_2 MESON. Aguilar-Benitez, M. (CERN, Geneva); Barlow, J.; Jacobs, L. D.; Malecki, P.; Montanet, L.; Tomas, M.; Della Negra, M.; Cohen-Ganouna, J.; Loerstad, B.; West, N. Phys. Lett., 29B: 62-5(Mar. 31, 1969).

Evidence from the K$\overline{K}$ decay mode for the splitting of the A_2 meson is presented. (auth)

23355 THE REACTION $pp \rightarrow pp\pi^+\pi^-$ AT 7.9 GeV/c. Grether, Donald Frank. Urbana, Ill., Univ. of Illinois, 1968. 153p.

Thesis.

The reaction $pp \rightarrow pp\pi^+\pi^-$ was studied at an incident momentum of 7.9 BeV/c using the Brookhaven 80-inch hydrogen bubble chamber. Approximately 3600 events of the reaction were identified; the cross section was determined to be 2.54 ± 0.13 mb. The reaction is found to be dominated by production of the quasi-three body final state $N^{*++}p\pi^-$. A simple one pion exchange model is compared to the data and is shown to give generally good results for invariant mass distributions for the entire final state, and for mass and angular distributions for the quasi-three body state. Discrepancies between the data and the model are found to be primarily associated with enhancements in the $N^{*++}\pi^-$ of $p\pi^+\pi^-$ mass distributions at about 1425 MeV and 1700 MeV. Examination of the 1425 MeV enhancement indicates an apparent interference process rather than an incoherent sum of one pion exchange background and resonance production; the enhancement could not be identified as the N*(1470), the P_{11} wave resonance of π^-p phase shift analysis. Examination of the $\pi^+ \pi^-$ mass distribution gives some indication for production of the ρ meson, but no indication of other $\pi\,\pi$ resonances. No evidence is found for resonances with Baryon number = 2. (Disser. Abstr.)

23356 ANTIPROTON-NUCLEON INTERACTION. Limentani, S. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). pp 108-27 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.

See CONF-671079.

A review is given of some of the available data on $\bar{p}$-p and $\bar{p}$-n interactions. The following topics are considered: total cross sections; elastic cross sections; two-body final states, $Y\overline{Y}$ and $N^*\overline{N}^*$; annihilations at rest and in flight; and some special projects such as tests of C, P, and CP invariance in strong interactions and proton electromagnetic form factors. 97 references. (L.B.S.)

23357 PION PRODUCTION AT 12° AND 15° IN PROTON-BERYLLIUM COLLISIONS AT 12.5 GeV/c. Asbury, J. G. (Argonne National Lab., Ill.); Cho, Y.; Derrick, M.; Ratner, L. G.; Wangler, T. P.; Krisch, A. D.; Lin, M. T. Phys. Rev., 178: 2086-8(Feb. 25, 1969).

The results of absolute-cross-section measurements for the production of π mesons of 3, 4, and 5 GeV/c in proton-beryllium collisions at 12.5 GeV/c are reported. Measurements were made of π^+ and π^- production at 15° to the incident proton direction, and of π^+ production at 12°. The production cross sections are about a factor of 2 larger than previously reported measurements. (auth)

Strong (Meson-Induced)

Refer also to abstracts 23339 and 23347–23351.

23358 (CEA-R-3685) 3,55 GeV/c Kp ELASTIC SCATTERING NEAR 180°. Duflo, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 104p. (In French). Dep.

Thesis. Submitted to Paris Univ., France.

Backward elastic K^+p and K^-p scattering was measured in the angular interval 168° < 0.c.m. < 177°. The experimental apparatus included optical spark chambers to measure the three prongs of the event scattering, a set of scintillation counters and Cerenkov counters to select events and trigger chambers, and a magnet to determine the moment of the recoil proton. There were 106,000 photographs taken. Of these, 22 satisfied all requirements as elastic K^+p scattering events. No event was found to satisfy the kinematical criteria for K^-p elastic scattering. The correspondent values of differential cross sections are: $(d\sigma/d\Omega)K^+\,p \rightarrow pK^+ = 17 \pm 4\ \mu b/sr$ and $d\sigma/d\Omega\ K^-p \leq 0.6\ \mu b/sr$. Contaminations by π p backward scattering and inelastic scattering were estimated. Elastic scattering $K^+ + p$ exhibits a backward peak. A reasonably satisfactory interpretation of the results is obtained by exchange models. There is, in fact, no definitely established particle which could intermediate the $Kp^- \rightarrow pK^-$ process in the exchange channel. That is in good agreement with the small value of the K^-p backward elastic scattering cross section. The results lend support to the conclusions of the interference model developed previously for π p backward scattering, and to qualitative previsions of the quark model. (auth)

23359 (LNF-69/4) TOTAL ETA-NUCLEON CROSS SECTION BY PHOTOPRODUCTION OF ETA MESONS IN COMPLEX NUCLEI. Note No. 427. Bacci, C.; Baldini-Celio, R.; Eponeshnikov, V. N.; Mencuccini, C.; Reale, A.; Salvini, G.; Spinetti, M.; Zallo, A. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Jan. 23, 1969. 8p. Dep.

The total cross section was measured for the process $\eta + N \rightarrow$ all channels. The average η momentum in the η – nucleon cms is 250 MeV/c. No change in momentum of the η is assumed when the η goes outside from inside the nuclear matter. The dependence of the photoproduction cross section on the mass number was measured for H, D, Li, C, Al, Cu, Ag, and Pb. The experimental arrangement was based on the detection of the two photons from the $\eta \rightarrow \gamma\gamma$ decay by using two total absorption Cherenkov counters. A large $\eta - N$ interaction cross section is found at an $\eta - N$ cms momentum of 250 MeV/c. (J.F.P.)

23360 (NP-17812) MASS SPECTROSCOPY OF HEAVY BOSONS AND SPIN-PARITY ANALYSIS WITH A NEW INSTRUMENT. Schuebelin, Peter (European Organization for Nuclear Research, Geneva (Switzerland)). Dec. 12, 1967. 161p. Dep.

Thesis. Submitted to Bern Univ., Switzerland.

The boson mass spectrum was investigated in the reaction $\pi^- + p \rightarrow p + X^-$ in the region $0.5 < M_X < 2.5$ GeV by means of the CERN Missing Mass Spectrometer, using the Jacobian peak method. Three new heavy bosons referred to as S, T and U mesons (M_S = 1929 MeV, M_T = 2195 MeV, M_U = 2382 MeV) were found. Their experimental widths are equal to the experimental resolution, of the order of 25 MeV. The mass region of the R meson has been investigated with large statistics. It is shown that the R meson is split into three, perhaps four peaks (M_{R_1} = 1630 MeV, M_{R_2} = 1700 MeV, M_{R_3} = 1748 MeV, M_{R_4} = 1830 MeV) each of them with width equal to the experimental resolution. The A_2 meson, first observed in bubble chambers, was measured with high statistics. It was found to be split into two peaks of equal width and height in all samples of good experimental resolution (16 to 18 MeV), whilst no splitting was seen in samples with larger resolution. In order to determine the still controversial spin-parity of the A_2 meson, a novel additional instrument to the Missing Mass Spectrometer has been developed and built: a digitized wide-gap wire chamber system with dimensions 1.5 × 1.5 m^2. The advantages of the new instrument are: excellent multiparticle efficiency, good measuring precision, and the possibility of being operated in an on-line experiment. With this instrument, an analysis of decay particles was possible. The Dalitz plot of the A_2 mass region favors the 2^+ spin-parity assignment over 2^- and 1^+. (auth)

23361 (PPAR–7) INTERACTIONS OF 290 MeV/c POSITIVE PIONS WITH DEUTERIUM. Norem, James H. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Dec. 5, 1968. Contract AT(30-1)-2137. 81p. Dep. CFSTI.
Thesis.

The total cross section and the differential cross section of the reactions $\pi^+d \rightarrow \pi^+d$, $\pi^+d \rightarrow \pi^+ + p + n$, $\pi^+d \rightarrow \pi^0 + p + p$, $\pi^+d \rightarrow \gamma + p + p$, and $\pi^+d \rightarrow p + p$ were measured using 85,000 pictures of 290-MeV/c π^+ in a 15" bubble chamber. The elastic, inelastic, and charge exchange scattering data are more complete and more accurate than any previously existing at or near this energy. Events were identified on the basis of range, ionization, coplanarity, and angular correlations of tracks. The cross section for radiative absorption (inverse photoproduction) was found to be consistent with predictions made on the basis of time reversal. Assuming reciprocity, the cross section for $\pi^+d \rightarrow pp$ was compared with other measurements of $\sigma(pp \rightarrow \pi^+d)$ and was found to be consistent. The spectator momentum spectrum was measured for the charge exchange scattering and was found to be consistent with the simple Hulthen wave function. This Hulthen spectrum was used in a Monte Carlo program to determine the detection efficiency for charge exchange and radiative absorption. (auth)

23362 (UCRL–18624) K^-p INTERACTIONS AROUND 1 GeV/c AND THE $Y_0^*(1815)$. Sahouria, Jack Yacoub S. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1969. Contract W-7405-eng-48. 90p. Dep. CFSTI.
Thesis.

The reaction $K^-p \rightarrow \Lambda\pi^+\pi^-$ in the center-of-mass energy range 1700 to 1850 MeV is analyzed under the assumption, which is well substantiated by the data, that the reaction proceeds mainly by the production of the intermediate state $Y_1^*(1385)$. A good fit to the production and decay angular distributions and the mass plots of the $Y_1^{*\pm}(1385)$ and the lambda polarization is obtained, showing the well known resonances $Y_1^*(1770)$ and the $Y_0^*(1820)$. This fit also requires a possibly resonating state with iso-spin, spin and parity $O(3/2^+)$ and mass at or below 1700 MeV which is the low end of the energy range in this experiment. The branching fractions of the states $Y_1^*(1770)$ and $Y_0^*(1820)$ into the final state $Y_1^{*\pm}(1385) + \pi^\pm$ are found to be (8.0 ± 3.3) per cent and (8.0 ± 1.4) percent respectively; and the phase between these two states is (201 ± 14), (136 ± 19) and (167 ± 25) degrees at the center-of-mass energies 1803, 1821 and 1846 MeV respectively. The masses of the Y_1^{*+} and $Y_1^{*-}(1385)$ and the mass difference $(Y_1^{*-} - Y_1^{*+})$ are obtained as (1384.2 ± 1.4) MeV, (1387.8 ± 1.2) MeV and (3.6 ± 1.0) MeV respectively. The interference between the iso-spin states 0 and 1 explains the difference between the production rates of the $Y_1^{*+}(1385)$ and the $Y_1^{*-}(1385)$ in the above reaction. (auth)

23363 ELASTIC BACKWARD SCATTERING OF PIONS AND KAONS. Baker, W. F. (CERN, Geneva); Carlson, P. J.; Chabaud, V.; Lundby, A.; Banaigs, J.; Berger, J.; Bonnel, C.; Duflo, J.; Goldzahl, L.; Plouin, F. Nucl. Phys., B9: 249-72(1969).

The elastic scattering of π^+ mesons by protons near 180° was measured at 2.85, 3.30, and 3.55 GeV/c, that of π^- mesons at 3.30 and 3.55 GeV/c, and that of K^+ and K^- mesons at 3.55 GeV/c. Steeply rising backward peaks are observed at all energies for π^+p scattering, whereas the π^-p angular distributions are not as steep. K^+p elastic scattering also shows a backward peak. No backward K^-p elastic scattering event was found. The upper limit (90% confidence) for the K^-p differential cross section is twelve times smaller than the corresponding K^+p cross section. The behavior of the differential cross section close to 180° can be explained using direct channel resonances. The large ratio of the K^+p to K^-p cross section can be understood in terms of baryon exchange. (auth)

23364 COHERENT K* PRODUCTION IN K^+d REACTIONS AT 3 GeV/c. Buchner, K. (Max Planck Institut fuer Physik und Astrophysik, Munich); Dehm, G.; Goebel, G.; (and others). Nucl. Phys., B9: 286-94(1969).

In a study of K^+d interactions at 3 GeV/c the following reactions were observed in which the deuteron does not break up: $K^+d \rightarrow K^0\pi^+d$, ($K^0$ seen) and $K^+d \rightarrow K^+\pi^+\pi^-d$. An abundant production of K*(892) is observed in these reactions. The production and decay angular distributions for K*(892) are presented. (auth)

23365 STUDY OF MULTI-BODY FINAL STATES IN K^+p REACTIONS AT AN INCIDENT MOMENTUM OF 5 GeV/c. Bassompierre, G. (CERN, Geneva); Goldschmidt-Clermont, Y.; Grant, A.; (and others). Nucl. Phys., B9: 295-305(1969).

Results are given on the comparison of the predictions of the multiperipheral model of Chan, Loskiewicz, and Allison with the experimental data obtained from a study of the interactions of 5 GeV/c K^+ mesons with protons. Comparisons were made in the three-, four-, five-, and six-body final states containing a proton, kaon, and pions. With the addition of resonance production to the model, adequate predictions of experimental distributions are obtained. An attempt is made to describe the energy variation of the three- and four-body final-state cross sections. (auth)

23366 MULTIPLE PION PRODUCTION IN K^+–PROTON COLLISIONS AT 3.5 GeV/c. Erwin, A. R. (Univ. of Wisconsin, Madison); Walker, W. D.; Goshaw, A. T.; Weinberg, A. Contract AT(11-1)-881. Nucl. Phys., B9: 364-402(1969).

An analysis is made of K^+ proton interactions in which three or four pions are produced. The experiment was conducted in the Brookhaven 80-inch bubble chamber using an incident beam of 3.5 GeV/c K^+ mesons. Events of the type $K^+ + p \rightarrow K^0 + p + (3 \text{ or } 4\pi)^+$ were selected from the four-prong plus V^0 topology. A search is made in these reactions for the production of excited states of the K meson which decay with the emission of one or more pions. The kappa (725) and K*(892) are discussed in some detail. Evidence is presented for a K* resonance of mass 1305 MeV. Upper limits are measured for the $K\omega$ and $K\eta$ decays of the K*(1420). A $K^{*+}(892)\pi^+$ enhancement is observed in these data at 1180 MeV. In addition to a study of K meson excited states, some properties of the ω and η mesons are studied in a production process with very little background. (auth)

23367 PRODUCTION OF K*(1300) AND K*(1400) RESONANCES IN K^+p INTERACTIONS AT 3.5 GeV/c. Bishop, J. M.; Goshaw, A. T.; Erwin, A. R.; Walker, W. D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Nucl. Phys., B9: 403-26 (1969).

In a recently completed experiment using 3.54 GeV/c K^+ mesons in the BNL 80" chamber, the two prong + V^0 topology for resonance production was investigated. Evidence was found for the K*(1300) with a narrow width with $K\pi\pi$ decay modes and the K*(1400) with $K\pi$, $K^*\pi$, $K\rho$ and $K\omega$ decay modes. Resonance positions, widths, cross sections and branching ratios are presented for these two K* resonances. (auth)

23368 A_1–NUCLEON CROSS SECTION FROM COHERENT PRODUCTION IN NUCLEI. Goldhaber, Alfred S. (State Univ. of New York, Stony Brook); Joachain, Charles J.; Lubatti, H. J.; Veillet, J. J. Phys. Rev. Lett., 22: 802-5(Apr. 14, 1969).

Comparison of A_1 coherent production in Freon with production in H_2 implies a total A_1-nucleon cross section $\sigma(A_1N) \leq (0.5^{+0.3}_{-0.2})\sigma(\pi N)$ with a further theoretical uncertainty of about 10%. The result appears to preclude the possibility, suggested by the Deck model, that the ρ and π in the A_1 are produced close together without appreciable interaction between them. (auth)

23369 ENERGY DEPENDENCE OF THE QUASI-FREE $(\pi^+,2p)$ REACTIONS AND EVIDENCE FOR THE REACTION $\pi^+ + (2N) \rightarrow \pi + p + p$ IN NUCLEI. Bressani, T.; Charpak, G.; Favier, J.; Massonnet, L.; Meyerhof, W. E.; Zupancic, C. (CERN, Geneva). Nucl. Phys., B9: 427-32(1969).

The cross sections of the $(\pi^+,2p)$ reactions in nuclei, leading to low-lying excited states, exhibit a resonance near 150 MeV incident energy, in close similarity to the free reaction $\pi^+ + d \rightarrow p + p$. This confirms that they proceed by a quasi-free mechanism. The missing-mass spectra show a rise at high mass values, which indicates a quasi-free process in nuclei, corresponding to the free non-peripheral reaction of the type $\pi^+ + d \rightarrow \pi^0 + p + p$. (auth)

23370 COHERENT FORMATION OF PARTICLES IN INTERACTIONS OF ~200 GeV π MESONS WITH PHOTOEMULSION NUCLEI. Chakhovska, Z.; Gerulya, E.; Kshivdzin'ski, S.; Mensovich, M.; Rybitski, K.; Vol'ter, V. (Inst. for Nuclear Research, Krakow). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 387-9 (1968). (In Russian).

An attempt was made of presenting proofs for coherent particle formation during pion collisions with photoemulsion nuclei at 200 GeV. Experiments were carried out at high elevation. The tracks of secondary particles (mainly pions) emitted at angles smaller than 10^{-2} rad were observed in 36 initial events of nuclear interactions at $\geq 10^{12}$ eV. Examination of 58.30 μm long tracks revealed 144 secondary interactions with mean energy of 200 GeV. The mean length of free path was (40.5 ± 3.4) μm. Tabulated data show that 13 interactions with multiplicity of

3 and 5 and $n_h = 0$ nearly nine were formed during the coherent generation process. Considering nine cases of coherent generation at 58 μm the mean length of path in the emulsion for pions with mean energy of ~200 GeV $\lambda_{\text{coherent}} \approx 6$ μm. For the 17-GeV π mesons this length is nearly 50 μm which shows that an effective cross section of coherent generation increases significantly with the energy. (R.V.J.)

23371 AN ANALYSIS OF ELASTIC π–^{4}He INTERACTIONS AT 129, 140, AND 150 MeV/c. Koetke, Donald D. Evanston, Ill., Northwestern Univ., 1968. 136p.
Thesis.

An analysis of elastic $\pi^{\pm}$–^{4}He interactions observed in the Northwestern University 50 cm liquid helium bubble chamber is presented. There were 250,000 tracks scanned for all $\pi^{\pm}$–^{4}He reactions, and the π^+ and π^- elastic differential scattering cross sections were measured as well as the total cross section for all inelastic reactions, in 3 momentum intervals with mean laboratory momentum 129, 140, and 150 MeV/c, respectively. (TSS) (Diss. Abstr.)

23372 $K^{\pm}p$ ELASTIC SCATTERING AT 3.55 GeV/c. Banaigs, J. (Centre d'Etudes Nucleaires, Saclay, France); Berger, J; Bonnel, C.; Duflo, J.; Goldzahl, L.; Plouin, F.; Baker, W. F.; Carlson, P. J.; Chabaud, V.; Lundby, A. Nucl. Phys., B9: 640-8(1969).

Results of measurements of $K^{\pm}p$ elastic scattering at 3.55 GeV/c in the cm angular ranges from 10° to 70° ($0.16 < -t < 2$ (GeV/c)^2) and from 100° to 170° ($3.4 < -t < 5.5$ (GeV/c)^2) are presented. These results complement previously published data which covered the angular region near 180°. Forward K^-p elastic scattering has a structure near $t = -1$ (GeV/c)^2, while the forward K^+p angular distribution is smooth. A backward peak is observed in the K^+p angular distribution, while the K^-p differential cross section decreases towards 180°. (auth)

23373 ANGULAR CORRELATION OF GAMMA-QUANTA PRODUCED BY NEGATIVE PIONS STOPPING IN HYDROGEN. Vasilevskii, I. M.; Vishnyakov, V. V.; Dunaitsev, A. F.; Prokoshkin, Yu. D.; Rykalin, V. I.; Tyapkin, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B9: 673-98 (1969).

The angular correlation of gamma-quanta emitted in the capture of stopped π^- mesons in hydrogen is measured. The measurements were performed by using scintillation and gas-discharge counter hodoscopes. The value of the mass difference between charged and neutral π mesons was found to be 4.6034 ± 0.0052 MeV/c^2. An upper probability limit for the production of a second neutral π meson, which has the mass in the range of 135–138 MeV/c^2 was determined. (auth)

23374 $\pi^-p \to K^0 + \Lambda^0(\Sigma^0)$ ASSOCIATED PRODUCTION BETWEEN 6 AND 11.2 GeV/c. Mannelli, I. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy); Pierazzini, G.; Scribano, A.; Sergiampietri, F.; Vincelli, M. L.; Caverzasio, C.; Guillaud, J. P.; Holloway, L. pp 42-52 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.
See CONF-671079.

A spark chamber experiment to measure the $\pi^-p \to K^0Y^0$ associated production at high energy was recently completed at the CERN PS. Data were taken at 6, 8, 10, 11.2 GeV/c for the incident π^- momentum. Preliminary results at 6 and 11.2 GeV/c based on 780 and 2140 events (about 30% and 50% of the available statistics) respectively, are presented. The sum of the $\pi^-p \to K^0\Lambda^0$ and $\pi^-p \to K^0\Sigma^0$ differential cross section is strongly peaked in the forward direction and can be well fitted for $|t_{\min}| < |t| < 0.35$ (GeV/c)^2 by an exponential shape e^{at} with $a = 7.7 \pm 0.5$ (GeV/c)$^{-2}$ at 6 and $a = 7.6 \pm 0.4$ (GeV/c)$^{-2}$ at 11.2 GeV/c. The integral over the interval $|t_{\min}| < |t| < 0.6$ (GeV/c)^2 gives 44 ± 7 μb at 6 and 20 ± 3 μb at 11.2 GeV/c, including systematic errors. A comparison is made with previous bubble chamber results. (auth)

23375 MEASUREMENT OF PARAMETERS A AND R IN $\pi^{\pm}$-p SCATTERING AT 5 TO 18 GeV/c. Amblard, B.; Beurtey, R.; Cozzika, G.; Ducros, Y.; Mansroul, M.; Merlo, J. P.; Mouchet, J.; Van Rossum, L. (CEN, Saclay, France). pp 22-23 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967. (In French).
See CONF-671079.

An experiment is prepared for the pion–nucleon interaction for angular distributions for $\pi^{\pm} + p \to \pi^{\pm} + p$, $\pi^- + p \to \pi^0 + n$ interactions, and polarization in the $\pi^- + p$ interaction. The measured quantities A and R correspond to measurements in the laboratory of the transverse polarization of the recoil proton in the reaction plane with a polarized target in a direction parallel or perpendicular to the direction of the incident pions. (J.F.P.)

23376 UPPER LIMIT ON THE $\eta \to \pi^0\gamma\gamma$ DECAY RATE. Bonamy, P.; Sonderegger, P. (CEN, Saclay, France). pp 84-95 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.
See CONF-671079.

An analysis was made of 754 events of the type $\pi^- + p \to n + 4\gamma$ at 4 GeV/c, produced in a spark chamber experiment. The four γ's were detected and their directions and energies measured (the latter to ±22%). No clear signal from the reaction $\pi^-p \to \eta n$ with the η decaying into $\pi^0\gamma\gamma$ is seen in this sample. By comparison with the $\eta \to 2\gamma$ decay mode observed in the same experiment, an upper limit of the branching fraction $R = [\Gamma(\eta \to \pi^0\gamma\gamma)/\Gamma(\eta \to \gamma\gamma)]$ of $R < 0.13$ (95% confidence level) is deduced. (auth)

23377 K^-p INTERACTIONS FROM 594 TO 820 MeV/c. Bertanza, L. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy); Bigi, A.; Carrara, R.; (and others). pp 128-36 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.
See CONF-671079.

Results are reported of K^--p elastic and charge-exchange scattering, studied in the BNL-Columbia hydrogen bubble chamber at 594 to 820 MeV/c. The results of a partial wave analysis are presented. (L.B.S.)

23378 π^-p MULTI-PION FINAL STATES AT 4.2 GeV/c. Luke, Robert A. Logan, Utah, Utah State Univ., 1968. 106p.
Thesis.

Approximately 56,000 frames from an exposure of film at the Berkeley Bevatron were scanned for six-prong events. The film was taken on the Alvarez 72 inch hydrogen bubble chamber. The momentum of the incident π^- beam was 4.158 ± 30 BeV/c. During the scanning process 1430 six-prong events were located and measured. The data were run using TVGP and SQUAW on a Univac 1108 computer. The overall cross section for six-prong production was found to be 0.4777 ± 0.0253 m barns. All possible particle combinations were analyzed utilizing invariant mass data for each possible combination. The data were searched for established resonances and the partial cross sections were calculated. There was a slight indication of a two-pion enhancement between 300–400 MeV. This enhancement was apparent in $\pi^+\pi^+$ and $\pi^-\pi^-$ data. No B enhancement was noted and a small indication of A_1 was observed. (Diss. Abstr.)

23379 NUCLEAR INTERACTIONS OF NEGATIVE PI MESONS AT 3.5 GeV/c. Warden, James Alva. Columbia, S. C., Univ. of South Carolina, 1968. 98p.
Thesis.

A two-part experimental study of negative pion-nucleus interactions at 3.5 GeV/c, using Ilford K.5 nuclear-track emulsions is presented. The first experiment deals with diffraction scattering. Using an optical model for the nucleus, the total diffraction and absorption cross sections per unit volume are calculated. The differential cross section for diffraction scattering, averaged over the constituents of emulsion, is derived from the Kirchhoff theory of scattering from a cloudy sphere. After a discussion of the location of events by scanning and the measurement of cross sections, the determination of the number of events per polar angle is described. Necessary corrections for scanning biases are introduced. Finally, a comparison with the theory is made, giving a measure of the pion-nucleus interaction radius of 1.01 ± 0.06 fermi. The theoretical cross sections are shown to compare favorably with the measured values; a comparison with similar results obtained at different incident momenta shows a general agreement. The second experiment is a survey study of the inelastic, or star, interactions found in emulsion. The predictions of several pertinent models, including the statistical model, the one pion exchange model, and the nuclear evaporation model, are examined as to validity in describing star interactions. The possibility of separating the interaction into two processes, an initial cascade and a later evaporation, is investigated. Using standard techniques, the mesonic component of the star secondaries is identified, providing a measure of the pion multiplicity of 2.67 ± 0.24; this is essentially the same as the result obtained for pion-nucleon interactions. The results of several studies, including compilation of angular, momentum, and effective mass distributions, are presented. A final comparison of the range spectrum of all nonmesonic secondaries with an evaporation calculation indicates that the assumption of a two-step process, while being qualitatively useful, is an oversimplification. (Diss. Abstr.)

23380 A_1 PRODUCTION IN 8 GeV/c π^+D INTERACTIONS. Cnops, A. M. (Brookhaven National Lab., Upton, N. Y.); Hough, P. V. C.; Huson, F. R.; (and others). Phys. Lett., 29B: 45-7 (Mar. 31, 1969).

The $\pi\rho$ system in the A_1 region is shown to have similar characteristics when produced in π-nucleon or coherent π^-D interactions. The $\pi\rho$ mass spectrum, which shows no evidence for narrow A_1 or $A_{1.5}$ production, agrees well with that predicted by the Reggeized Deck model. (auth)

23381 STOPPING-POWER DIFFERENCES BETWEEN POSITIVE AND NEGATIVE PIONS AT LOW VELOCITIES. Heckman, Harry H.; Lindstrom, Peter J. (Univ. of California, Berkeley). Phys. Rev. Lett., 22: 871-4(Apr. 28, 1969).

Measurements of grain densities of stopping π^+ and π^- mesons in emulsion show that, in the velocity interval $0.051 < \beta < 0.178$, the energy-loss rates of π^+ mesons exceed that of the π^- by amounts of 0 to 60 MeV/cm. The reported range differences between positive and negative particles are satisfactorily accounted for by the results of this experiment. (auth)

23382 φ-MESON PRODUCTION CROSS SECTION IN π^-p INTERACTIONS AT 2.13 GeV/c. Bollini, D.; Buhler-Broglin, A.; Dalpiaz, P.; Massam, T.; Navach, F.; Navarria, F. L.; Schneegans, M. A.; Zichichi, A. (CERN, Geneva. Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna. Centre de Recherches Nucleaires, Strasbourg). Nuovo Cim., 60A: 541-54(Apr. 21, 1969).

The production of the φ-meson in the reaction $\pi^- + p \rightarrow \varphi + n$ was studied using scintillation counters. The neutron was detected by a large-acceptance neutron detector and both its time of flight and its emission angle were measured to identify the missing mass. The decay mode $\varphi \rightarrow K^+K^-$ was detected using two scintillation counters in a simple coincidence arrangement. The total production cross section of the φ-meson at 2.13 GeV/c turns out to be $\sigma(\pi^- + p \rightarrow \varphi + n) = (24 \pm 8)\ \mu b$. This result confirms the depression factor, already observed for φ production in πN interactions, expected on the basis of the λ-quark spin conservation. (auth)

23383 FOUR-CHARGED-PARTICLE FINAL STATES FROM THE INTERACTION OF 2.7-GeV/c π^+ ON DEUTERIUM. Miller, R. J.; Lichtman, S.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 178: 2061-81(Feb. 25, 1969).

Reactions leading to four nonstrange, charged particles from the interaction of 2.7-GeV/c π^+ on deuterium were studied. Only events containing at least one visible stopping proton track were included. The spectator model of the π^+d interaction was examined and found to be a good approximation. This model not only gives a good description of the final state of the spectator nucleon, but is also supported by the similarity of such reactions as $\pi^+d \rightarrow pp\rho^0$ and $\pi^-p \rightarrow n\rho^0$. Meson (M) resonance production in the reaction $\pi^+d \rightarrow ppM$ is prominent, including $\eta(0.21 \pm 0.04$ mb), $\omega(0.80 \pm 0.08$ mb), $\rho(2.20 \pm 0.25$ mb), f(0.51 ± 0.20 mb), $A_1(0.17 \pm 0.10$ mb), $A_2(0.14 \pm 0.08$ mb), and $\eta'(0.05 \pm 0.02$ mb) (errors are statistical). The baryon resonance $\Delta(1238)$ is also observed to be produced in a variety of reactions. The ρ and ω production processes were examined in some detail, including a determination of the spin density matrix elements. Also, the 3π system in the $pp\pi^+\pi^-\pi^0$ final state was studied at energies near the A_1 and A_2 masses in an attempt to separate these particles from the several other processes contributing to this final state. The results of a spin-parity analysis of the A mesons are presented. (auth)

23384 SEARCH FOR MOMENTUM-DEPENDENT FLUCTUATIONS IN PION-PROTON SCATTERING NEAR 1.04 GeV/c. Bowen, T.; Dawes, W. R. Jr.; DeLise, D. A.; Jenkins, E. W.; Jones, J. J.; Kalbach, R. M.; Malamud, E. (Univ. of Arizona, Tucson). Phys. Rev., 178: 2082-6(Feb. 25, 1969).

This experiment examined $\pi^- + p$ elastic scattering in the region of incident momenta from 1.02 to 1.06 GeV/c. A momentum spectrometer, which provided a determination of the momentum of individual incident pions with an accuracy of 0.1%, permitted a search for rapid momentum-dependent fluctuations in the cross sections. Such fluctuations could be explained by a statistical process which has been successfully applied to low-energy nuclear-scattering experiments. Within the errors of the experiment no fluctuations of this nature were observed. (auth)

23385 STUDY OF THE $K^-d \rightarrow K^-\pi^+\pi^-pn$ REACTION AT 2.24 BeV/c. Rhode, J. I.; Scandrett, J. H.; Martin, H. J. Jr.; Crittenden, R. R.; Alyea, E. D. Jr. (Indiana Univ., Bloomington). Phys. Rev., 178: 2089-94(Feb. 25, 1969).

Results are reported for the following reactions: $K^-n \rightarrow K^-\pi^+\pi^-n$ (301 events), $K^-p \rightarrow K^-\pi^+\pi^-p$ (317 events), $K^-d \rightarrow K^-\pi^+\pi^-d$ (11 events), and $K^-d \rightarrow K^-\pi^+\pi^-pn$ where both nucleons have laboratory momenta greater than 250 MeV/c (245 events). The K^-n reaction is dominated by the $N^{*-}K^-\pi^+$ [(71 ± 7)%] final state. The K^-p reaction exhibits $K^-\pi^-N^{*2+}$ [(27 ± 5)%], $K^-\pi^+N^{*0}$ [(16 ± 5)%], $\overline{K}^{*0}N^{*0}$ [(11 ± 4)%], and $Y_0^*(1520)\ \pi^+\pi^-$ [(9 ± 3)%] production. Phase-space background accounts for about 25% of the reaction. The $K^-d \rightarrow K^-\pi^+\pi^-pn$ reaction with two high-momentum nucleons shows production of the N^{*-} and N^{*2+}. There is very little $\overline{K}^{*0}$ production. (auth)

23386 MUON PAIR PRODUCTION BY 12-GeV/c NEGATIVE π AND K MESONS ON CARBON AND IRON. Wehmann, A. A. (Harvard Univ., Cambridge, Mass.); Engels, E. Jr.; Hoffman, C. M.; Innocenti, P. G.; Wilson, Richard; Blanpied, W. A.; Drickey, D. J.; Hand, L. N.; Stairs, D. G. Phys. Rev., 178: 2095-2109 (Feb. 25, 1969).

The apparatus, method of data analysis, and results of a spark-chamber experiment on the production of muon pairs by 12-GeV/c π^- and K^- mesons incident on carbon and iron are discussed in detail. Based on these measurements, the best values for the ρ^0-meson mass and width are $M_\rho = 765 \pm 7$ MeV and $\Gamma_\rho = 95 \pm 19$ MeV, while the branching ratio $\Gamma(\rho^0 \rightarrow \mu^+\mu^-)/\Gamma(\rho^0 \rightarrow \pi^+\pi^-) = (5.6 \pm 1.1) \times 10^{-5}$. Values of the spin-density matrix elements $\rho_{\lambda\lambda'}$ for the dimuon system in the mass range $600 \leq M_{\mu\mu} \leq 900$ MeV are given as functions of the square of the momentum transfer from the incident particle. Results of a qualitative study of the $\mu^-\mu^+\pi^-$ system are reported. A value for the branching ratio $\Gamma(\phi^0 \rightarrow \mu^+\mu^-)/\Gamma(\phi^0 \rightarrow \text{all})$ and upper limits on decay modes $\Gamma(\eta^0 \rightarrow \mu^+\mu^-)/\Gamma(\eta^0 \rightarrow \text{all})$ and $\Gamma(\eta^0 \rightarrow \pi^0\mu^+\mu^-)/\Gamma(\eta^0 \rightarrow \text{all})$ are also given. The invariant-mass spectrum of the muon pairs shows no evidence for the existence of a $J = 1^-$ isovector meson, other than the ρ^0, up to 1300 MeV. (auth)

23387 η PRODUCTION IN THE REACTION $\pi p \rightarrow \pi p\eta$ AT 1050 AND 1170 MeV/c. Grossman, Ronald A.; Price, LeRoy R.; Crawford, Frank S. Jr. (Univ. of California, Berkeley). Phys. Rev., 178: 2109-28(Feb. 25, 1969).

A study was made of η production in the reaction $\pi^+p \rightarrow \pi^+p\eta$ at 1050 and 1170 MeV/c, and in the reaction $\pi^-p \rightarrow \pi^-p\eta$ at 1170 MeV/c. The following partial cross sections were obtained for the reaction $\pi^\pm p \rightarrow \pi^\pm p\eta$ followed by the charged decay $\eta \rightarrow \pi^+\pi^-\pi^0$: $9.5 \pm 1.5\ \mu b$ for 1050-MeV/c incident π^+; $53.3 \pm 5.0\ \mu b$ for 1170-MeV/c π^+; $15.9 \pm 1.9\ \mu b$ for 1170-MeV/c π^-. From our π^+ data it is found that four $I = 3/2$ amplitudes are needed in order to obtain good agreement with our mass and angular distributions and to reproduce the threshold behavior of the cross section. The dominating amplitude is found to be that representing the reaction $\pi^+p \rightarrow \eta\Delta(1238)$, $\Delta(1238) \rightarrow \pi^+p$, where the η and the $\Delta(1238)$ are produced in s wave. The four amplitudes are extrapolated to higher energies where the predicted mass and angular distributions and cross sections are compared with the available data. From the π^- data it is found that in addition to the four $I = 3/2$ amplitudes (determined from the π^+ data), one $I = 1/2$ amplitude is required: the amplitude in which all particles are in relative S states. It is found that this $I = 1/2$ amplitude in fact dominates the π^- reaction. No evidence is seen for production of an $N^*(1550) \rightarrow \eta p$ resonance. The cross sections for $\pi p \rightarrow \pi p\eta$ are parametrized from threshold to 4 BeV/c. (auth)

23388 THE REACTIONS $K^-p \rightarrow \Sigma^\pm\pi^\mp$, $\Sigma^\pm\pi^\mp\pi^+\pi^-$, AND $\Sigma^\pm\pi^\mp K^+K^-$ AT 4.1 GeV/c AND 5.5 GeV/c. Loos, James Stavert. Urbana, Ill., Univ. of Illinois, 1968. 231p.

Thesis.

The data presented and discussed were obtained from K^-p interactions at 4.1 GeV/c and 5.5 GeV/c in the MURA thirty-inch hydrogen bubble chamber. K^- track lengths equivalent to 0.95 μb per event and 0.27 μb per event were analyzed at 4.1 GeV/c and 5.5 GeV/c, respectively. Differential cross sections are given for the $\Sigma^\pm\pi^\mp$ final states, and the results obtained in this experiment agree well with the extrapolated results from lower energies. The data for $\Sigma^+\pi^-$ are interpreted in terms of the Regge pole model. A search for the existence of hyperon resonances in the mass region above 1900 MeV/c^2 is made in the $\Sigma^\pm\pi^\mp\pi^+\pi^-$ data, but no evidence for such resonances is found. Consistent with results from lower energies, this reaction appears to be dominated by quasi-three-body processes in which either the $Y_0^*(1405)$, $Y_0^*(1520)$, or $\rho(770)$ is produced. Cross sections and production angular distributions for the various resonance productions are given. Production of $Y_0^*(1405)$, $Y_0^*(1520)$, and $\phi(1020)$ are observed in the $\Sigma^\pm\pi^\mp K^+K^-$ data. Cross sections and production angular distributions are given for the observed resonant processes. A measurement of the mass and width of the $\phi(1020)$ yields a mass of 1020.8 ± 1.0 MeV/c^2 and a width of 1.7^{+}_{-}[illegible] MeV/c^2. (Disser. Abstr.)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 23322.

General

Refer also to abstract 23593.

23389 (ITF-68-82) ABOUT COLLISION-PROCESS LIFETIMES AND CAUSALITY. Ol'khovskii, V. S.; Recami, E. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 19p. Dep.

Previous results are generalized by calculating and defining reaction and partial-process lifetimes in the case of two-wave-packet collisions with an arbitrary number of final packets. Besides, the principle of causality and the new one of "anticausality" are expressed in terms of interaction time shifts. (auth)

23390 (ITF-68-85) ASYMPTOTICALLY EXACT CALCULATION OF CORRELATION FUNCTIONS. Bogolyubov, N. N. Jr. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 15p. Dep.

The problem of asymptotically exact calculation of multiple time correlation functions of any order and corresponding Green's functions for the model system with four fermion interaction is considered. Asymptotical expressions for such correlation functions are obtained. (auth)

23391 (ITF-68-86) CORRELATION FUNCTIONS FOR SYSTEMS WITH FOUR-FERMION INTERACTION. Bogolyubov, N. N. Jr. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 15p. Dep.

The methods of construction of some important majoration inequalities for the model system with four-fermion negative interaction are under development. (auth)

23392 (JINR-P1-4279) DALITZ PLOTS FOR MANY-PARTICLE SYSTEMS IN THE INVARIANT VARIABLES. Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 16p. (In Russian). Dep.

The Dalitz plot in the reaction $m_0 \rightarrow m_1 + m_2 + m_3$ for the variables (m_{23}^2, m_{12}^2) is generalized for more complex systems. The plot for the variables (m_{12}^2, m_{234}^2) in the reaction $m_0 \rightarrow m_1 + m_2 + m_3 + m_4$ coincides with the Dalitz plot in the reaction $m_0 \rightarrow m_1 + m_2 + (m_3 + m_4)$ joined with angle b of the circumscribed rectangle. The plot for the variables (m_{234}^2, m_{134}^2) in the same reaction coincides with the Dalitz plot in the reaction $m_0 \rightarrow m_1 + (m_2 + m_3) + m_4$ joined with angle d of the similar rectangle. The plot for the variables (m_{123}^2, m_{345}^2) in the reaction $m_0 \rightarrow m_1 + m_2 + m_3 + m_4 + m_5$ coincides with the Dalitz plot for the reaction $m_0 \rightarrow (m_1 + m_2) + m_3 + (m_4 + m_5)$ joined with angles a and b of the rectangle. (auth)

23393 (JINR-P1-4290) THE MONTE CARLO SIMULATION OF PERIPHERAL INTERACTIONS. [PART] I. Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 15p. (In Russian). Dep.

The Monte-Carlo simulation of the processes with high multiplicity is considered especially for peripheral collisions. (auth)

23394 COVARIANT POLARIZATION MATRIX FOR ARBITRARY SPIN PARTICLES. Gabos, Zoltan. Stud. Univ. Babes-Bolyai, Ser. Math.-Phys., 13: No. 2, 85-94(1968). (In French).

The structure of covariant polarization matrix was found for particles with zero and nonzero rest mass for coherent and noncoherent superpositions of pure states. Expressions are given for cases in which the spin is $1/2$, 1, $3/2$, and 2. (R.V.J.)

23395 SEMI-STATISTICAL MODEL OF HIGH-ENERGY COLLISIONS. Jabs, Arthur (Univ., Kiel). Z. Phys., 222: 1-32(1969).

The emission of particles directly created in high-energy collisions is considered to be only partly governed by statistical laws as in Fermi's model. The motion of the created particles is to some degree related to the former motion of the incoming colliding particles. In first approximation this intermediate state is built up of two extremes: two Lorentz systems are introduced from which the particles are emitted isotropically and according to statistical laws. In the center-of-momentum system (CMS) of the collision these two systems move in the directions of the incoming particles after collision. This approximation corresponds to the two-fireball model which is regarded as a representative of a mathematical method of dealing with correlations. In further approximation phase space distributions are replaced by the thermodynamic Fermi or Bose distributions for relativistic particles. Both experimental data such as the nearly constant mean transverse momentum $\overline{p}_t$ and phase space calculations with constant interaction volume show that the temperature kT reaches an upper limit asymptotically at high energies; the asymptotic region begins at about 30 GeV. The comparison with experimental particle spectra from accelerators in the 10-30 GeV region shows good agreement if one uses a smooth dependence of kT on the collision energy E_0 and, for each independent set of measurements, an individual choice of $\overline{\gamma}_f$, the mean Lorentz factor of the "fireballs" in the CMS, and of $\bar{n}$, the mean number of created particles. The p_t-distribution of pions and the dependence of $\overline{p}_t$ on the particle mass can also be successfully described. At very high energies the model gives production ratios of the various kinds of particles which lie within the range of the experimental determinations. The dependence of $\overline{\gamma}_f$ on E_0 is concluded to be of the form $\overline{\gamma}_f \propto E_0^{1/4}/\bar{n}(E_0) \approx 0.5\ E_0^{1/4}$, i.e., CMS anisotropy is related to multiplicity. (auth)

23396 PROPAGATION OF SIGNALS AND PARTICLES. Ferretti, B. (Univ., Bologna). pp 108-19 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

Problems relative to elementary particles are reviewed. Some questions related to the physical interpretation of the relativistic quantum mechanics formalism to the extent that this formalism is usable and valid are considered. Also through an example, the problematics of the description of possible phenomena in which the space-time is essential in a sphere are discussed. (J.F.P.)

23397 PRODUCTION OF THE η-PARTICLE AND THE EXTENT OF OUR PRESENT UNDERSTANDING. Salvini, G. (Univ., Rome). pp 281-303 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

The meson (η) is discussed as an example of general knowledge of elementary particle theory. The meson (η) is used as an example of predictions of elementary particles, the advancement of experimental information of the production mechanism of a particle and the framing of the experimental results in low-energy theories and also at high energies. Finally, possible experiments through the use of new instruments are considered in order to verify present unitary theories and the present lack of adequate experimental detectors in elementary particle physics. (J.F.P.)

23398 OLD AND NEW PROBLEMS IN ELEMENTARY PARTICLES. A VOLUME DEDICATED TO GILBERTO BERNARDINI IN HIS SIXTIETH BIRTHDAY. Puppi, G. (ed.). New York, Academic Press Inc., 1968. 319p.

The book included 20 sections. Separate abstracts were prepared for 19 sections. One section on supergain antenna was not abstracted. (J.F.P.)

For abstracts of individual sections see: 23320, 23321, 23328-23330, 23343, 23396, 23397, 23415-23418, 23439-23441, 23522, 23532, 23550, and 23563.

23399 METHOD AND SOME RESULTS IN CURRENT IDENTITIES. Taha, M. O. (Inst. for Advanced Study, Princeton, N. J. Downing Coll., Cambridge, Eng.). Nuovo Cim., 60A: 651-62(Apr. 21, 1969).

A method is given for the manipulation of functions in the theory of currents. Limits in which the integrals may be evaluated are discussed. The conditions for the covariance of the retarded product are given both in general form and in these limits, assuming convergence and neglecting infinite-mass contributions. Useful equalities following from the equivalence of the various limits are obtained and discussed. (auth)

23400 SUM RULES AND HIGH-ENERGY BEHAVIOR. Taha, M. O. (Inst. for Advanced Study, Princeton, N. J. Downing Coll., Cambridge, Eng.). Nuovo Cim., 60A: 663-8(Apr. 21, 1969).

Three sum rules (in ν, u, and v) are obtained from current identities using a recently introduced method. It is asserted that a pole fixed at J = 0 is required to contribute to the high-energy behavior in the symmetric channel. (auth)

23401 FIRST-ORDER WAVE EQUATIONS FOR HALF-ODD-INTEGRAL SPIN. Capri, Anton Z. (Univ. of Alberta, Edmonton). Phys. Rev., 178: 2427-33(Feb. 25, 1969).

A method is described for finding first-order wave equations without subsidiary conditions for particles of half-odd-integral spin and nonzero mass. The method is illustrated in the cases of spins $1/2$, $3/2$, and $5/2$. (auth)

23402 CONSISTENT DYNAMICAL FORMULATION OF CURRENT-CURRENT THEORIES AND THE VALIDITY OF CURRENT ALGEBRA. Cohen, S. L. (Univ. of Oregon, Eugene); Guralnik, G. S. Phys. Rev., 178: 2229-39(Feb. 25, 1969).

It is shown that the usual formulations of current-current theories are not dynamically consistent, because of the occurrence of Schwinger terms. On the basis of the Poincaré-group algebra, an alternative and consistent formulation is constructed and generalized to allow for parity and isospin violation. It is found that, with the appropriate normalization of currents and corresponding definitions of coupling constants, the chiral algebra of currents for time components is always satisfied in four-dimensional theories of the current-current type. In the two-dimensional case, this statement needs modification, but it is essentially valid there as well. The algebra involving spatial components is highly sensitive to the dynamics, and consequently is not identical to the free-quark-field case. In certain cases of parity violation, the usual currents which couple in the field equations do not transform as four-vectors even though the theory itself is covariant. This is somewhat analogous to radiation-gauge electrodynamics. It is found, however, that it is possible to construct new covariant currents as linear combinations of the components of the old currents which have the property that they couple covariantly into the field equation. Because of these complications, the spatial components of the covariant currents do not have a definite parity and do not transform as vectors in isospin. (auth)

23403 QUANTUM MECHANICS OF PARAPARTICLES. Hartle, James B. (Univ. of California, Santa Barbara); Taylor, John R. Phys. Rev., 178: 2043-51(Feb. 25, 1969).

It is shown that it is possible to formulate a consistent first-quantized theory of paraparticles, i.e., particles which are neither bosons nor fermions. A number of properties of the theory are examined and it is shown that the formulation of Messiah and Greenberg in terms of generalized rays can be replaced by an equivalent formulation in which states are represented by rays in the usual way. This alternative formulation is used to establish some results of ordinary quantum mechanics. The consistency of the theory with the cluster law is examined in detail and it is shown that paraparticles must have states associated with whole families of different permutation symmetries, according to the following rule: If a given particle has N-particle states associated with a given Young diagram, then it must have (N−1)-, (N−2)-, . . ., two-particle states associated with all Young diagrams which can be obtained from the first by successively removing squares. This gives rise to infinitely many different kinds of paraparticle, all with rather complicated properties. (auth)

Electromagnetic

Refer also to abstracts 23327, 23397, 23444, 23503, 23526, and 23553.

23404 (ITF-68-87) ABOUT SCHROEDINGER'S REPRESENTATION IN A QUANTUM-MECHANICAL PROBLEM. Oleinik, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 24p. (In Russian). (CONF-680949-3). Dep.

From 2nd Conference on Statistical and Physical Kinetics, Ukrainian, SSR.

The scalar product of solutions of Dirac's equation for an electron in the external field is shown to depend on time, there is no orthogonal basis in the space of these solutions. It means that based on Schrödinger's representation it is impossible to give a probable interpretation to the solutions of Dirac's equation in the problem under consideration and to describe logically successively the behavior of a quantum system. Dirac was the first to prove the incorrectness of Schrödinger's representation in some problems. (auth)

23405 ON THE PHOTOPRODUCTION OF THE Δ^{2+} ISOBAR. Meyer, A. F. A. (Institut fuer Hochenergiephysik, Berlin). Nucl. Phys., B9: 244-8(1969).

Experimental data for the reaction $\gamma p \rightarrow \Delta^{2+}\pi^-$ for photon energies up to 1.8 GeV are compared with the predictions of the intermediate isobar model. (auth)

23406 RECOIL-DEUTERON VECTOR POLARIZATION IN ELASTIC ELECTRON SCATTERING. Ramachandran, G. Indian Statistical Inst., Calcutta). Phys. Rev. Lett., 22: 794-5 (Apr. 14, 1969).

The vector polarization of the recoil deuterons in the elastic scattering of electrons on deuterons is shown to be nonzero if the deuteron S and D states differ in phase and an expression for the polarization is given in terms of the isoscalar electromagnetic form factors of the nucleon and the deuteron radial integrals. (auth)

23407 SEARCH FOR THE PROCESS $e^- + e^- \rightarrow \mu^- + \mu^-$. Barber, W. C. (Massachusetts Inst. of Tech., Cambridge); Gittelman, B.; Cheng, D. C.; O'Neill, G. K. Contracts AT(30-1)-2098; AT(04-3)-515; NONR-1858(39). Phys. Rev. Lett., 22: 902-5(Apr. 28, 1969).

Speculating on the possible existence of a strong muon–electron coupling which has escaped observation because of a multiplicative muon conservation law, the process $e^- + e^- \rightarrow \mu^- + \mu^-$ was looked for. An upper limit was set on the cross section of 0.67×10^{-32} cm^2 and it is concluded that such a coupling, if it exists, is no stronger than 610 times the normal vector coupling of weak interactions. (auth)

23408 ROTATION OF FRAME AND THE VECTOR-DOMINANCE DISCREPANCY FOR $\pi^\pm$ PRODUCTION BY POLARIZED PHOTONS. Diebold, R. (Stanford Univ., Calif.); Poirier, J. A. Phys. Rev. Lett., 22: 906-7(Apr. 28, 1969).

Experimental data on $\pi^\pm$ production by polarized photons are compared with a vector-dominance model prediction which is independent of a possible ambiguity regarding the frame used to evaluate the ρ^0 density matrix; a discrepancy of more than a factor of 2 is found. (auth)

23409 PHOTON–PHOTON SCATTERING AND PHOTON–SCALAR PARTICLE SCATTERING VIA GRAVITATIONAL INTERACTION (ONE-GRAVITON EXCHANGE) AND COMPARISON OF THE PROCESSES BETWEEN CLASSICAL (GENERAL-RELATIVISTIC) THEORY AND THE QUANTUM LINEARIZED FIELD THEORY. Boccaletti, D. (Istituto Nazionale di Fisica Nucleare, Bologna. Univ., Ferrara, Italy); de Sabbata, V.; Gauldi, C.; Fortini, P. Nuovo Cim., 60B: 320-30(Apr. 11, 1969).

The cross sections for the photon–photon scattering and for the photon–scalar particle scattering both with classical and with quantum linearized theory of gravitation are calculated. We find a sort of a correspondence-principle connection between these two different methods and it is again confirmed that the gravitational action of a beam of light is twice as great as would be calculated on a Newtonian basis if we regarded the beam as filled with matter with the same energy density. (auth)

23410 PHOTOPRODUCTION OF PIONS ON ^{3}He AND ^{3}H. Sanchez-Gomez, J. L.; Pascual, P. (Univ. of Valencia). Nucl. Phys., B9: 153-63(1969).

The photoproduction of pions on nuclei with three nucleons is considered in the "elastic" channels. The calculation is done using the impulse approximation and neglecting rescattering effects. (auth)

23411 MULTIPLE-SCATTERING CORRECTIONS TO HIGH-ENERGY π^+ PHOTOPRODUCTION. Benfatto, G.; Nicolo, F.; Rossi, G. C. (Univ., Rome). Nuovo Cim., Lett., 1: 537-43 (Apr. 11, 1969).

A model recently proposed by Frautschi and Margolis that allows multiple scattering corrections to be generated in the form of Regge cuts is extended to π^+ photoproduction, obtaining for the high-energy differential cross section a very good agreement with experimental data until $|t| \simeq 0.8$ (GeV/c)^2. It is also shown that the pion's conspirator is not needed to reproduce the peak of the differential cross section in the forward direction. (L.B.S.)

23412 THE REACTION $\gamma \rightarrow \rho^0 p$ AS TWO-PION EXCHANGE. Schreiber, H. J. (Institut fuer Hochenergiephysik, Berlin). Nucl. Phys., B9: 164-8(1969).

The predictions of the two-pion exchange model (TPEM) are calculated for the total cross section at photon energies of 4.4 GeV, the differential cross section and the decay angular distribution for the ρ^0 meson in its rest frame. The results show this model is unable to describe the experimental data. (auth)

23413 SHAPE OF MESONS. Lo, S. Y. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys., B9: 10-16(1969).

From Chou-Yang's model for high-energy scatterings numerical values of the form factors π, K, ρ, ω, ϕ are deduced in analogy to the proton form factor. It is concluded that (i) the π, K form factors are incompatible with the naive vector meson dominance model for $t \neq 0$, and (ii) the process $\gamma + p \rightarrow \phi + p$ is crucial to the validity of the model. Further it is pointed out that the qualitative features of the results are valid for other similar models as well. (auth)

23414 DISPERSION RELATIONS FOR ELECTROPRODUCTION PARTIAL-WAVE AMPLITUDES. Gehlen, G. v. (Univ., Heidelberg). Nucl. Phys., B9: 17-54(1969).

From fixed-t dispersion relations a set of integral equations are derived for the electroproduction partial wave amplitudes. The kernels which couple the different equations are calculated explicitly. The calculation is made possible with reasonable amount of labor by using parity conserving helicity amplitudes and by taking advantage of the MacDowell reflection symmetry. The kernels are explicitly separated into a simple singular diagonal part and a complicated remainder which is regular in the physical region. Care is taken of the fact that the conventional relativistic amplitudes A_2 and A_5 contain a kinematic pole at $t = \mu^2$. A method for solving the equations is briefly discussed. (auth)

23415 DIRAC MAGNETIC POLES. Amaldi, E. (Univ., Rome). pp 1-61 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

The main properties of Dirac poles, the spin, electric dipole moment, and mass, coupling constant and production cross section are discussed. Also energy losses by ionization, Cherenkov emission and bremsstrahlung, scattering and binding are covered. Experimental searches for Dirac poles using accelerators and primary cosmic rays are considered. Finally, Dirac's monopole theory is discussed including properties of symmetry of a theory which includes magnetic poles, and the first and second quantizations. (J.F.P.)

23416 HADRONIC CONTRIBUTIONS TO THE PHOTON PROPAGATOR. Lee, T. D. (Columbia Univ., New York); Zumino, B. pp 167-76 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

It is shown that the entire hadronic contribution to the charge renormalization is finite by assuming that the isovector part of the unrenormalized electromagnetic current is the same operator, apart from a possible constant multiplicative factor, as the unrenormalized strong-interaction current generating the neutral meson (ρ). It is also assumed that the isoscalar part is the same as an appropriate linear combination of the corresponding two current operators generating the mesons (ϕ) and (ω), independently of the unrenormalized masses of these mesons being finite or infinite. It is shown that in the absence of leptons these conclusions can be extended to include all orders in e^2. (J.F.P.)

23417 PROSPECTS FOR THE MUON-ELECTRON PROBLEM. Lederman, L. M. (Columbia Univ., New York). pp 156-66 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

An understanding is sought for the organization of leptons comparable to that of hadrons. Static properties of the leptons, high-energy electromagnetic processes, and weak interactions are covered. (J.F.P.)

23418 SUM RULES FOR PHOTON PROCESSES. Drell, S. D.; Primack, J. R. (Stanford Univ., Calif.). pp 101-7 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

A theoretical experiment carried out on the hydrogen atom is considered, and new sum rules are proposed for elementary particles. These rules are not rigorously derived but are to be understood as analog results. (J.F.P.)

23419 MAGNETIC MOMENT OF THE Σ^+ HYPERON. Rybicki, Krzysztof (Instytut Badan Jadrowych, Krakow). Postepy Fiz., 20: 9-19(1969). (In Polish).

A review is given on the determination of the magnetic moment of the Σ^+-hyperon. Unitary-symmetry predictions concerning the magnetic moment are briefly discussed. A method of the determination of μ_{Σ^+} taking advantage of its precession in a strong magnetic field and making use of the asymmetry of the $\Sigma^+ \rightarrow p + \pi^0$ decay is described. Five experimental papers published in 1964 to 1968 using the method have been reported. Experimental apparatus, scanning, selection criteria and procedures used in each work have been described. The world-average result $\mu_{\Sigma^+} = (2.7 \pm 0.6)\ \mu_N$ is discussed. (auth)

23420 π^0 PHOTOPRODUCTION ON PROTON AT BACKWARD ANGLES BETWEEN 700 AND 1150 MeV. Delcourt, B.; Lefrancois, J.; Parrour, G.; Perez-Y-Jorba, J. P.; Sauvage, G. (Ecole Normale Superieure, Orsay, France). Phys. Lett., 29B: 70-4(Mar. 31, 1969).

π^0 photoproduction cross sections on proton were measured at π^0 cm angles between 115 and 180° and between 700 and 1150 MeV photon energies by detecting only the recoil proton. The results show clearly a peak at 135° around 1000 MeV energies as predicted by Walker's partial wave analysis. (auth)

23421 ELECTROMAGNETIC FORM FACTOR OF THE π^+ AND SINGLE PION ELECTROPRODUCTION NEAR THRESHOLD. Nicolo, F. (Univ., Rome). pp 274-86 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.

See CONF-671079.

The possibility of determining the π^+ form factor from experiments of electroproduction of π^+ on protons near the threshold, where only the outgoing electrons are detected, is discussed. (L.B.S.)

23422 SINGLE PION ELECTROPRODUCTION. Berkelman, K. (CERN, Geneva). pp 265-73 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.

See CONF-671079.

Single pion electroproduction in the reactions $e + p \rightarrow e + n + \pi^+$ and $e + p \rightarrow e + p + \pi^0$ is discussed. The connection between electroproduction and photoproduction and various possibilities for electroproduction experiments are discussed. (L.B.S.)

23423 η-DECAY: THEORETICAL QUESTIONS. Jacob, M. (CERN, Geneva). pp 233-64 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.

See CONF-671079.

The results presently available for η decay are analyzed from a theoretical point of view. This discussion is, however, aimed at experimentalists. It insists on the implications of mixing which is now required. It also presents the still open theoretical question concerned with the large value of the pionic decay rates. (auth)

23424 LEPTONIC DECAY OF NEUTRAL PSEUDOSCALAR MESONS. Kessler, Paul (College de France, Paris). Compt. Rend., Ser. A, B, 268: 445-8(Feb. 10, 1969). (In French).

In the context of the study of electromagnetic form factors, interest in experiments of the type $\eta\ (\eta') \rightarrow \gamma + l^+ + l^-$ is discussed. (tr-auth)

23425 KAON MASS DIFFERENCE, K_A AND K^* DECAYS. Tanaka, K. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., 60A: 589-98(Apr. 21, 1969).

In a model in which the intermediate states of K and K_A are considered in virtual photon-kaon scattering, it is shown that the nature and sign of the electromagnetic kaon mass difference $\Delta m_K = m_{K^+} - m_{K^0}$ depend on a parameter δ_K that can be obtained from the decay rates $K_A \rightarrow K^*\pi$ and $K^* \rightarrow K\pi$. For favorable values of δ_K that yield the experimental decay rates, the kaon mass difference is logarithmically divergent and can have the correct sign ($\Delta m_K < 0$), provided the cut-off is large enough. On the other hand, if the Δm_K is required to be convergent, one obtains $\Delta m_K > 0$ and a weak form of Weinberg's second sum rule in $SU_3 \times SU_3$. (auth)

23426 FOURTH-ORDER VACUUM POLARIZATION CONTRIBUTION TO THE SIXTH-ORDER ELECTRON MAGNETIC MOMENT. Mignaco, J. A. (Univ., Geneva); Remiddi, E. Nuovo Cim., 60A: 519-29(Apr. 21, 1969).

The contribution of fourth-order vacuum polarization to sixth-order radiative correction to the electron magnetic moment is analytically evaluated and found to be $0.055\ (\alpha/\pi)^3$. (auth)

23427 BARYON RESONANCES FROM ELECTRON-POSITRON COLLIDING BEAMS. Celeghini, E. (Istituto Nazionale di Fisica Nucleare, Florence); Gatto, R. Nuovo Cim., 60A: 599-614 (Apr. 21, 1969).

A compact formalism, derived previously and applied there to production of meson resonances in electron-positron collisions, is applied to calculate the expected angular correlations in electron-positron collisions leading to baryon resonances, which subsequently undergo a sequence of decays. The possibility of polarized initial beams is considered and the distributions are given in terms of the parameters specifying such polarization. (auth)

23428 EXCHANGE-DEGENERATE CONSPIRATORS IN π^+ PHOTOPRODUCTION. Ahmadzadeh, Akbar; Jacob, Richard J.; Nigam, B. P. (Arizona State Univ., Tempe). Phys. Rev., 178: 2284-7(Feb. 25, 1969).

Photoproduction of positively charged pions near the forward direction is considered in a Regge-pole model consisting of exchange-degenerate π and B conspiracies. (auth)

23429 HIGH-ENERGY LIMIT FOR THE REAL PART OF FORWARD COMPTON SCATTERING. Creutz, Michael J.; Drell, Sidney D.; Paschos, Emmanuel A. (Stanford Univ., Calif.). Phys. Rev., 178: 2300-1(Feb. 25, 1969).

The contribution of a pole at $\alpha = 0$ to forward Compton scattering is investigated using finite-energy sum rules. It is concluded than an experiment measuring the total photoabsorption cross section from ~1 to 10 to 15 BeV with an accuracy of 5% will detect a contribution from such a pole whose magnitude is larger than 30% of the Thomson limit. (auth)

23430 DASHEN-FRAUTSCHI METHOD AND THE ELECTROMAGNETIC COUPLINGS OF THE DEUTERON. Milgrom, M. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev., 178: 2343-9(Feb. 25, 1969).

Using a Dashen–Frautschi-type method, the magnetic moment and electric quadrupole moment of the deuteron are calculated. These quantities are expressed in terms of dispersion integrals involving the photodisintegration of the deuteron; we then approximate these integrals by the contribution from the one-nucleon-exchange cuts. The results for both moments coincide with those of the Schroedinger-theory calculation when the binding is neglected. It is also found that the multipole amplitudes for $\gamma d \rightarrow pn$ enjoy McDowell-type symmetry properties in the energy plane. This method gives a framework for further relativistic refinements. (auth)

23431 ELECTRIC DIPOLE MOMENT OF THE NEUTRON IN THE V-Ae$^{i\phi}$ THEORY OF WEAK INTERACTIONS. McNamee, Peter (Univ. of Maryland, College Park. Woodstock Coll., Md.); Pati, Jogesh. Phys. Rev., 178: 2273-7(Feb. 25, 1969).

The electric dipole moment d of the neutron is estimated in a theory where weak interactions are mediated by an intermediate boson and where CP violation arises from phase angles between vector and axial-vector currents. Following the dispersion-theoretic tadpole model of Babu and Suzuki, d is evaluated in terms of the π^0 and η photoproduction amplitudes and the strengths of the π^0 and η tadpoles. The strengths of these tadpoles are evaluated in the soft-pion and soft-η limits, respectively, by making use of the hypothesis of partially conserved axial-vector current, current algebra, and Weinberg's sum rules. The result is found to diverge logarithmically with the mass of the intermediate boson. The contribution of the η tadpole is found to be negligible for most cases, when compared with that of the π^0 tadpole. Making reasonable estimates of the photoproduction amplitudes, the dipole moment is found to be $|d| \simeq 0.9 (\sin \phi + 0.06 \sin \xi) \times 10^{-19}$ e cm if the mass of the intermediate boson is 5 BeV; ϕ and ξ are the phase angles associated with the strangeness-conserving and strangeness-violating axial-vector currents, respectively. (auth)

23432 BACKWARDS TWO-BODY PROBLEM OF CLASSICAL RELATIVISTIC ELECTRODYNAMICS. Driver, Rodney D. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 178: 2051-7 (Feb. 25, 1969).

The two-body problem of classical electrodynamics can be formulated in terms of action at a distance by using the retarded Liénard–Wiechert potentials (or a combination of retarded and advanced potentials). The resulting equations of motion in the retarded case, for example, form a complicated functional delay-differential system. For such equations in the case of one-dimensional motion, as shown in an earlier paper, one can specify rather arbitrary past histories of the particles, and then solve for the future trajectories. Yet it is often assumed or asserted that unique trajectories would be determined by the specification of Newtonian initial data (the positions and velocities of the particles at some instant). Simple examples of delay-differential equations should lead one to doubt this. For example, even if the values of x and all its derivatives are given at t_0, the equation $x'(t) = ax(t) + bx(t - \tau)$, with $\tau > 0$ and $b \neq 0$, still has infinitely many solutions valid for all t. Nevertheless, under certain special conditions for the electrodynamic equations it is found that instantaneous values of positions and velocities do indeed determine the solution uniquely. The case treated involves two charges of like sign moving on the x axis, assumed to have been subject only to their mutual retarded electrodynamic interaction for all time in the past. The similar questions of existence and uniqueness for a more general model, e.g., three-dimensional motion or half-retarded and half-advanced interactions, or even for charges with opposite signs remain open. (auth)

23433 CONTINUUM CONTRIBUTIONS TO THE PION RADIUS. Blaha, Stephen (Rockefeller Univ., New York). Phys. Rev., 178: 2167-9(Feb. 25, 1969).

Continuum contributions to the mean-square radius of the pion are calculated. The calculation is based on the assumption of vector dominance of the hadronic electromagnetic current. Vector dominance is introduced through the use of field-current identities which relate the $\gamma\pi\pi$ form factor to the $\rho\pi\pi$ form factor. Then dispersion and elastic unitarity equations are assumed in order to determine the $\rho\pi\pi$ form factor. In particular, the $\pi\pi$ interaction used in the elastic unitarity equation is assumed to consist of t-channel exchange of a ρ meson. The case is also considered where the $\pi\pi$ interaction consists of t-channel exchange of a scalar σ meson. In both cases, continuum contributions to the pion radius were found to be small compared to the pole contribution. (auth)

23434 EFFECT OF ELECTROMAGNETIC FIELD ON DECAY OF ELEMENTARY PARTICLES. Ritus, V. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 986-1005(Mar. 1969). (In Russian).

Decay probabilities are obtained for muons, $\mu \rightarrow e\tilde{\nu}\nu$, pions, $\pi^{\pm} \rightarrow \pi^0 e^{\pm}\nu$, $\pi \rightarrow \mu\nu$, $e\nu$ and neutrino-emitting electrons $e \rightarrow e\tilde{\nu}\nu$ in a strong varying or stationary electromagnetic field. The characteristic properties of the processes are considered and parameters are found which define the dependence of the probability of field strength for various ratios of the particle masses and particularly for small mass differences which raise the sensitivity of the probability to the field strength. Depending on the type of decay interaction between the particles, the external electromagnetic field may either increase or decrease the decay rate. It is shown that the probability which depends on the external field $F_{\mu\nu}$ via the parameter $\chi = \sqrt{(eF_{\mu\nu}p_\nu)^2}/m^3$ possesses a singularity at point $\chi = 0$. (auth)

Weak

Refer also to abstracts 23417, and 23488.

23435 (PPAR–8) PROPERTIES OF K_{l3} DECAY IN THE $\pi-\nu$ CENTER OF MASS SYSTEM: A STUDY OF THE FORM FACTORS. Marateck, Samuel L.; Rosen, S. P. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Feb. 18, 1969. Contracts AT(30-1)-2137; AT(30-1)-2171. 15p. Dep. CFSTI.

It is shown that in K_{l3} decays, the lepton-neutrino correlation in the $\pi-\nu$ cm system is linear for constant form factors assuming $f_T = 0$; in particular for $K_{\mu 3}$, certain values of ξ (0) and λ_- in the theoretically anticipated range lead to observable departures from linearity. The l-ν correlation is used to show the difficulty involved in obtaining a small lower limit on f_s/f_+ for K_{e3} and the subsequent effect on ξ (0) and λ_- is discussed. (auth)

23436 UNITARY SUM RULE FOR $K_S - K_L$ DECAY. McGlinn, W. D.; Polis, D. (Univ. of Notre Dame, Ind.). Phys. Rev. Lett., 22: 908-9(Apr. 28, 1969).

A new unitary sum rule for $K_S - K_L$ decay is derived by use of a phenomenological S matrix. (auth)

23437 FIRST AND SECOND CLASS WEAK HADRONIC CURRENTS AND THEIR IMPLICATIONS FOR K_{l3} DECAYS IN AN EXTENDED CABIBBO MODEL. Bender, I.; Linke, V.; Rothe, Heinz J. (Univ., Heidelberg). Nucl. Phys., B9: 141-52(1969).

Within the framework of a generalized Cabibbo model for the weak hadronic current in which the current is allowed to transform like an arbitrary mixture of SU(3) multiplets, thus accomodating possible $\Delta S = -\Delta Q$, ΔS, $\Delta S = 2$, and $\Delta I = {}^3/_2$ transitions, the concept of a first and second class strangeness non-changing, CP conserving current is extended to the strangeness changing, CP violating case. Using the experimental information on the branching ratio $\Gamma(K^- \rightarrow \pi^0 e^- \bar{\nu})/\Gamma(K_L \rightarrow \pi^+ e^- \bar{\nu})$, predictions are made for the quantity $(1 - |x|^2)/|1 - x|^2$, where $x \equiv A(K^0 \rightarrow \pi^+ e^- \bar{\nu})/A(\bar{K}^0 \rightarrow \pi^+ e^- \bar{\nu})$ and the decay ratio $\Gamma(\eta \rightarrow \pi^+ e^- \bar{\nu})/\Gamma(\pi^- \rightarrow \pi^0 e^- \bar{\nu})$ assuming that the current is either first or second class. It is found that a first class current leads to predictions which are in good agreement with experiment. (auth)

23438 P-ODD EFFECTS IN (ep) AND (μp) SCATTERING. Lobov, G. A.; Shabalin, E. P. (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys., B9: 75-80(1969).

P-odd effects in (ep) and (μp) scattering are calculated. The theory of renormalizable weak interaction being valid, these effects prove to be $\approx 1\%$ at $E \approx 10$ GeV. It is estimated that the statistical accuracy obtained on accelerators with $E \gtrsim 10$ GeV and with the intensity $\approx 10^{14}$ electrons/sec makes it possible to verify the existence of the P-odd effects in question. (auth)

23439 TEN YEARS OF THE UNIVERSAL (V–A) THEORY OF WEAK INTERACTIONS. Marshak, R. E. (Univ. of Rochester, N. Y.). pp 177-201 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

The theory of weak interactions is reviewed. This review includes the Puppi triangle, parity nonconservation in meson (μ) leptonic decays and semileptonic nucleon and meson (π) decays, chiral projections, V–A interactions, the interaction Hamiltonian, and four-fermion interactions. Electron–muon universality, hadron and lepton currents, the CVC hypothesis, the Cabibbo angle, current algebra for P-wave amplitudes for nonleptonic hyperon decays, and a unified theory of elementary particles are also discussed. (J.F.P.)

23440 UNIVERSAL WEAK COUPLING AND NONLEPTONIC INTERACTIONS. Radicati, L. A. (Scuola Normale Superiore, Pisa, Italy). pp 272-80 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

A form of the weak Lagrangian which ensures the validity of the $\Delta T = \frac{1}{2}$ rule for the nonleptonic processes and also reproduces all the known features of the leptonic and semileptonic ones is discussed. The Lagrangian considered follows from the requirement that the nonleptonic processes satisfy a condition which expresses the universality of the weak coupling. (J.F.P.)

23441 A SIMPLE APPROACH TO THE ADLER–WEISBERGER RELATION. Weisskopf, V. F. (Massachusetts Inst. of Tech., Cambridge). pp 304-9 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

A derivation of the Adler–Weisberger relation which connects the ratio of the two weak coupling constants of the nucleon, vector and axial vector coupling, with an integral over pion absorption cross sections is given. This derivation is not a genuine one. It is an incomplete derivation using only nonrelativistic approximations. However, the derivation illustrates some of the essential ideas involved in this relation. (J.F.P.)

23442 HIGH-ENERGY BEHAVIOR OF SCATTERING DUE TO MASSLESS (NEUTRINO) EXCHANGE. Rajaraman, R. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 178: 2211-20(Feb. 25, 1969).

A method of calculating the high-energy behavior of some processes is devised where massless particles are being exchanged and the normal theorems such as the Froissart bound cannot be directly applied. The processes are ν-ν and ν-$\bar{\nu}$ scattering, with a long-range potential due to the exchange of neutrinos. It is shown that as the energy E tends to infinity, (i) the ν-ν and ν-$\bar{\nu}$ total cross sections behave as constants, (ii) the ν-ν and ν-$\bar{\nu}$ cross sections approach each other (a Pomeranchuk theorem), and (iii) the long-range two-neutrino exchange force is of the form E/r^5. The calculation is made with the assumption that the amplitudes obey the Mandelstam representation, no restrictions are made to any specific order in the weak coupling constant G, or to any specific form of the Hamiltonian. The high-energy behavior is deduced by constructing a consistency condition to it. Using analyticity and unitarity, the potential due to the massless neutrino exchange is shown to depend on the high-energy behavior of the ν-ν and ν-$\bar{\nu}$ processes. Since, in turn, the high-energy cross sections of these processes are themselves dependent on the potential, a consistency requirement is available on the former, leading to the results mentioned above. (auth)

23443 SELF-CONSISTENT HIGH-ENERGY SCATTERING OF ZERO-MASS LEPTONS: THE COUPLED-CHANNEL CASE. Rajaraman, R. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 178: 2221-5(Feb. 25, 1969).

The method devised in a preceding article for calculating a consistent high-energy behavior of neutrino scattering due to neutrino exchange is extended to the case of two coupled massless fermions. It is argued that the two fermions either could be the two types of neutrinos, ν_e and ν_μ, or could even be massive leptons like the electron, as long as the mass is small compared to $1/\sqrt{G}$. If we call the two particles a and b, it is shown that the a-a, a-$\bar{a}$, b-b, and b-$\bar{b}$ total cross sections, due to the exchange of $a\bar{a}$ and $b\bar{b}$ pairs, approach constant values as the energy tends to infinity. It is further shown that the a-a and a-$\bar{a}$ cross sections approach one another, as do the b-b and b-$\bar{b}$ cross sections. On the other hand, the a-b and a-$\bar{b}$ cross sections vanish at high energies. (auth)

23444 MODELS FOR K AND η DECAYS. Greenberg, David (Univ. of Chicago). Phys. Rev., 178: 2190-7(Feb. 25, 1969).

Simple meson-pole models for nonleptonic K and η decays are presented in the context of current-current Lagrangians for the weak and electromagnetic interactions; consistency with low-energy theorems of current algebra is demonstrated and comparison made with experiment. It is shown that violations of the $\Delta I = 1/2$ rule may be attributed to η-π mixing. (auth)

23445 TIME-REVERSAL INVARIANCE AND THE DECAY $\pi^\pm \to e^\pm \bar{\nu}_e e^+ e^-$. Flagg, Wayne (Stanford Univ., Calif.). Phys. Rev., 178: 2387-9(Feb. 25, 1969).

A model of radiative pion decay which incorporates a violation of time-reversal invariance is studied. An asymmetry of up to 12% in the angular distribution of particles in the final state is predicted. (auth)

23446 NUCLEAR EVIDENCE AGAINST THE d'ESPAGNAT THEORY OF NONLEPTONIC WEAK INTERACTIONS. McKellar, Bruce H. J. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 178: 2160-2(Feb. 25, 1969).

The weak parity-violating nuclear force predicted by the d'Espagnat theory of nonleptonic weak interactions is calculated. It is found to be in conflict with the observed circular polarization of γ rays from heavy nuclei. In contrast, the predictions of the Cabibbo theory are consistent with the data. (auth)

23447 SECOND-ORDER SYMMETRY BREAKING IN K_{l3} DECAYS. de Alwis, S. P.; Nutbrown, D. A. (Univ. of Cambridge, Eng.). Phys. Rev., 178: 2163-4(Feb. 25, 1969).

Using current algebra, partially conserved axial-vector current (for pion and kaon), and scalar and pseudoscalar meson dominance for two-point functions, K_{l3} decay parameters are calculated. The spectral-function sum-rule estimates for F_K/F_π and F_κ/F_π are used in the numerical evaluation. (auth)

23448 DECAY RATE OF $\Sigma^+ \to p + \gamma$ FROM UNSUBTRACTED DISPERSION RELATIONS. Papaioannou, G. M. (Univ. of Illinois, Urbana). Phys. Rev., 178: 2169-76(Feb. 25, 1969).

Assuming unsubtracted dispersion relations, integral representations are formulated for the weak photonic amplitudes F_1 and F_2. The integrals involve the magnetic and electric dipole amplitudes M_{1-} and E_{0+} of the photo-pion production and the pion-nucleon scattering phase shifts of the states P_{11}, P_{31}, S_{11}, and S_{31}. The integrals were carried out on a computer and the relative decay rate of $\Sigma^+ \to p\gamma$ to its total rate was found to be 0.71×10^{-3}, which is comparable with the latest experimental value $(1.9 \pm 0.4) \times 10^{-3}$. (auth)

Strong (General)

Refer also to abstract 23469.

23449 LONGITUDINAL PHASE-SPACE PLOTS OF MULTIPARTICLE HADRON COLLISIONS AT HIGH ENERGY. van Hove, L. (CERN, Geneva). Nucl. Phys., B9: 331-48(1969).

The accurate study of collisions with more than two particles in the final state is greatly hampered by the high dimensionality of the phase space in which the distribution of final states must be investigated. Taking advantage of the fact that in hadron collisions at high energy all transverse momenta remain generally small, phase space is separated into its longitudinal and transverse parts, and it is shown that for a n-particle collision the longitudinal phase-space distribution reduces to a manifold of dimension n-2. A study is made of the main properties of longitudinal phase-space plots, the way in which relativistically invariant subenergies and momentum transfers vary along them, as well as the qualitative properties of Reggeized multiperipheral amplitudes. The longitudinal phase-space plot is parametrized by new angular variables $\omega_1, \ldots \omega_{n-2}$ and the interest of plotting events against them is demonstrated. The paper ends with a new method for Monte Carlo integration of phase-space integrals. (auth)

23450 SUPERCONVERGENT BOOTSTRAP, EXCHANGE DEGENERACY, AND FIXED SINGULARITIES IN THE COMPLEX J-PLANE. Matsuda, Satoshi (Tokyo Univ.). Nucl. Phys., B9: 113-40(1969).

The dynamical scheme based on the generalized superconvergence relations (GSCR) or the finite energy sum rules (FESR) is considered. This scheme is called the superconvergent bootstrap, where crossing is imposed by the GSCR (or FESR). The fundamental approximation is that the scattering amplitude can be approximated by a finite number of Regge poles. The bootstrap scheme investigated here is based on the narrow-resonance approximation which allows one to make the simple and systematic parametrization of the Regge parameters based on analyticity and unitarity. The bootstrap program is then to find a set of mutually consistent Regge trajectories and determine their parameters self-consistently. The superconvergent bootstrap is carried out for the reaction $P + P \to P + V$, where P and V stand for the pseudoscalar and vector-meson octet respectively. Exact SU(3) symmetry is assumed. Solving the bootstrap equations algebraically, it is shown that the coupled vector- and tensor-octet trajectories can bootstrap themselves quite satisfactorily. The interesting mass formula $3m_V^2 = m_T^2 + 3m_P^2$ is obtained, where m_M denotes the mass of a M-meson octet and T stands for the tensor-meson octet. The formula is well satisfied experimentally. As was shown by Mandelstam and Wang, the singular behavior of the Regge residues when the trajectories pass through wrong-signature nonsense points is critically dependent on whether or not fixed singularities are present in the Froissart-Gribov partial-wave amplitude at nonessential values of J with the wrong signature, or equivalently, whether the contribution of the third double-spectral function of the scattering amplitude is neglected or taken into account. From the bootstrap equations the close connection between exchange degeneracy and the above mentioned fixed singularities: in the limit of exchange degeneracy any contribution from the wrong-signature singularities of the Regge residues at nonsense points of α vanishes, while conversely, exchange degeneracy comes out when vanishing of the above contribution is required. This statement is proved quite generally based on the crossing properties of the scattering amplitudes. The dynamical scheme is also applied to the reaction $P + P \to P + 1$, where ω stands for the vector-meson singlet. This reaction is dominated by only the vector-octet trajectory in each channel. Solving the bootstrap equation the single vector-octet trajectory is also shown to bootstrap itself quite satisfactorily. (auth)

23451 APPROXIMATE SOLUTION OF THE NONRELATIVISTIC LEE MODEL IN ALL SECTORS. Nickle, M. H. (Duke Univ., Durham, N. C.). Contract DA-31-124-AROD-13. Phys. Rev., 178: 2382-4(Feb. 25, 1969).

An approximate solution of the nonrelativistic Lee model in all sectors is described. The treatment is valid only in the strong-coupling regime, but the restriction to large source radius, characteristic of North's strong-coupling solution, has been eliminated. (auth)

23452 HADRONIC CURRENTS. II. Flory, David; Susskind, Leonard (Yeshiva Univ., New York). Phys. Rev., 178: 2254-63(Feb. 25, 1969).

In a series of earlier papers, a theory of self-induced strong interactions was proposed by Frye and Susskind. The matrix elements of additive currents were conjectured to satisfy simple "X representations." It is shown that a class of quantities called "limit projections" defined at infinite momentum have certain properties which can be proved in perturbation theory. These properties imply immediately the X representations conjectured for currents. Further, these limit projections are shown to be closely related to matrix elements of currents at infinite momentum. (auth)

23453 CLOSED FORMS FOR THE SCATTERING AMPLITUDES AND BOOTSTRAP BASED ON SUM RULES. Altarelli, G.; Rubinstein, H. R. (New York Univ., N. Y.). Phys. Rev., 178: 2165-6(Feb. 25, 1969).

An infinite class of solutions of the superconvergence equations is constructed with no restrictions on masses and Regge residues. Implications for bootstraps based on sum rules are discussed. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 23397 and 23453.

23454 (JINR–P1-4280) ABOUT THE KINEMATICS OF RESONANCE PAIR PRODUCTION. Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 14p. (In Russian). Dep.

For the decay $0 \to A + B \to (1 + 2) + (3 + 4)$ the region in which the invariant masses of pairs 1 + 3 and 2 + 4 change is found. (auth)

23455 EXCHANGE DEGENERACY, FLAT TOTAL CROSS SECTIONS, AND THE ABSENCE OF EXOTIC RESONANCES. Lipkin, Harry J. (Weizmann Inst. of Science, Rehovoth, Israel). Contract F–61052-68-C-0070. Nucl. Phys., B9: 349-63(1969).

Conditions imposed on Regge trajectories by requiring flat total cross sections for all reactions in "exotic" channels are systematically investigated under very general conditions. For meson-meson scattering, a degenerate quartet of trajectories coupled to kaons and pions with quantum numbers of the ω, ρ, f^0 and A_2 is required, plus an additional trajectory coupled only to kaons. Additional optional trajectories include $(\rho', f^{0\prime})$ pairs coupled only to pions, $(\omega', f^{0\prime})$ and (ρ', A_2') pairs coupled only to kaons and quartets coupled to both kaons and pions. A quark model with universal U(3) symmetry is shown to be the unique solution consistent with broken SU(3) symmetry and having flat exotic total cross sections for meson-meson scattering. Other solutions also exist for meson-baryon and baryon-baryon scattering. For $\Delta\bar{\Delta}$ scattering, there is no solution; isospin considerations show that non-trivial saturation of finite-energy or superconvergent sum rules is impossible without exotic $(I \geq 2)$ contributions. The nature of the required exotic contributions in baryon-antibaryon scattering is discussed. (auth)

23456 FROM THE HISTORY OF DETECTION OF π^- AND K-MESONS. Powell, S. F. Priroda, No. 11, 22-32(Nov. 1968). (In Russian).

A review of the studies which led to the determination of the properties of π^- and K mesons is given. The first experiments with the Cockcroft–Walton generator (750 keV) and the first use of the photographic method of analysis for subatomic particles are noted. Further experiments determining the mass of these species and other experiments relating to other aspects of atomic physics, including the preparation of transuranium elements, are shown to be related, particularly in the most recent experiments. The expense of more recent and future experimentation calls for international cooperation; such cooperation at CERN, Geneva, and at Serpukhov is reviewed. Instrumentation at CERN and Dubna is briefly described. A call for parallelism of technical progress with pure scientific advances as mandatory for the speed with which the present world moves is made. (BBB)

23457 RADIATIVE CORRECTIONS TO $\varphi \to K\bar{K}$ DECAY. Cremmer, E.; Gourdin, M. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., B9: 451-9 (1969).

The electromagnetic corrections to the $\varphi \to K\bar{K}$ decay are computed as the product of phase-space corrections due to the K^+, K^0 mass difference by radiative corrections in the second-order approximation. The final result is $\Gamma(\varphi \to K^+K^-)/\Gamma(\varphi \to K^0\bar{K}^0) = 1.60$. (auth)

23458 VENEZIANO MODEL FOR π–ρ SCATTERING. Abers, Ernest S.; Teplitz, Vigdor L. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev. Lett., 22: 909-12(Apr. 28, 1969).

A Veneziano model for the odd-normality (π) contributions to $\pi\rho$ double-charge-exchange scattering is found. In the model, the leading trajectory is not parity doubled and its residues satisfy the factorization condition. An argument is given for the existence of high-mass exotic resonances. (auth)

23459 CURRENT-ALGEBRA APPLICATIONS IN KAON PHYSICS. Roy, Probir. Stanford, Calif., Stanford Univ., 1968. 67p.

Thesis.

Three specific problems in K-meson physics, each illustrating the application of the chiral SU(3) $\otimes$ SU(3) algebra of the universal hadronic currents, are considered. The first problem deals with the consistency of the soft-pion approximations in the weak, semileptonic $K_{l3}[K \to \pi e(\mu)\nu]$ and $K_{l4}[K \to \pi\pi e\nu]$ decays in understanding the value of the K_{l3} parameter ξ. In the second problem we test the kaonic pole-dominance hypothesis in the KN system by calculating the S-wave $I = {}^3\!/_2$ and $I = {}^1\!/_2$ scattering lengths and the S-wave K^+P effective range and comparing with experiment. The third problem considers a low-energy dominated sum rule for $K\pi$ scattering and the crucial relation between the accuracy of kaonic pole-dominance in the $K\pi$ system and the existence of the κ-meson. (Diss. Abstr.)

23460 AN EQUATION FOR MESON STATES IN THE QUARK MODEL AND ITS APPLICATION TO A MESON BOOTSTRAP. King, Lawrence Gray. Urbana, Ill., Univ. of Illinois, 1968. 74p.

Thesis.

A differential equation for meson states is derived from the Bethe–Salpeter equation under the conditions of the quark model. The equation is shown to imply mass relations of the form $K^{*2} - \rho^2 = K^2 - \pi^2$. The equation is used to attempt bootstrap calculations of the vector and pseudo-scalar meson parameters in the quark model. A bootstrap is found for the SU_3 singlet states but shown not to be possible for either the octet states or the entire $\bar{Q}Q$ system. The potential is the Fourier transform of the sum of one meson exchange Feynman graphs, with a hard core radius r_0 introduced as an adjustable parameter. With the choice $r_0 = 0.58$ F, $M_{Quark} = 5.45$ BeV, $\varkappa = 2M_Q f_V/g_V = -0.24$, the self-consistent coupling constants g_{V2}, g_{P2} imply in and out "unmixed" singlet masses that are equal and correct. With the same g_{V2}, g_{P2}, the hard core radius and $\varkappa$ are altered to produce 0^-, 1^- states at the π, ρ masses. In addition to π, ρ, and K, the s-wave states $\eta(523)$, $\eta'(985)$, $\omega(785)$, $\varphi(1018)$, $K^*(896)$ are found as well as excited states including the following: B(1018), $A_1(1230)$, $A_2(1407)$. Assuming the correct $A_2(1310)$, the nonet structure $K^*(1393)$, f(1323), f′(1476) is found. (Diss. Abstr.)

23461 EFFECT OF CROSSED-CHANNEL ISOSPIN-TWO AMPLITUDE AND THRESHOLD UNITARITY ON s-WAVE π–π SCATTERING LENGTHS. Levers, R. G. (Univ. of Alberta, Edmonton). Nuovo Cim., 60A: 575–88(Apr. 21, 1969).

Weinberg's current-algebra calculation of the s-wave π–π scattering lengths incorporates neither $I = 2$ amplitude in the crossed (t) channel nor the unitarity condition, and the below-elastic-threshold conditions on the π^0–π^0 amplitude as determined by Jin and Martin are not satisfied. By generalizing the usual isoscalar σ model and incorporating s-wave elastic-threshold unitarity in the manner of Iliopoulos one is led to four sets of solutions for a given $I = 2$ amplitude in the t-channel, all of which satisfy the below-threshold conditions. By considering the continuity of the coefficients of the scattering-amplitude power-series parametrization in terms of the imaginary momentum variables k_s, k_t, k_u of Iliopoulos from first to second order it is concluded that only one solution is meaningful. Surprisingly this gives Weinberg's results almost exactly in the limit of no I = 2 amplitude in the t-channel. (auth)

23462 TYPE-III CONSPIRACY OF THE FEYNMAN AMPLITUDE. Kikkawa, K. (Univ. of Rochester, N. Y.). Nuovo Cim., 60A: 530-40(Apr. 21, 1969).

For a certain class of Feynman amplitudes with elementary-particle exchange it is shown that the type III conspiracy occurs without referring to the Reggeization. In order to see the behavior of the pion conspiracy such a class of amplitudes is studied in detail under the assumption of the Van Hove–Durand procedure. It is shown that, for the pion trajectory to be type III, the conventional expansion of the scattering amplitude in terms of the propagator should be revised in two respects. i) One must include the propagator for particles with $M \geq 1$ (M being the smallest spin in the irreducible representation of the Lorentz group to which the particle belongs). This is different from most discussions where propagators are constructed only for M = 0. ii) One must consider the mixing between M = 0 and $M \neq 0$ representations. (auth)

23463 DISPERSION-THEORETIC APPROACH TO HARD-PION CURRENT-ALGEBRA RESULTS FOR ρ-π AND A_1-π SCATTERING. Gupta, K. C. (Univ. of Notre Dame, Ind.); Vaishya, J. S. Phys. Rev., 178: 2177-86(Feb. 25, 1969).

Following recent attempts to explore possible connections between current algebra, dispersion relations, and Regge pole theory, ρ-π and A_1-π scattering amplitudes are considered, and both are calculated from the hard-pion current algebra for four-point functions and dispersion relations with saturation by single-particle intermediate states. The two are found to lead to mutually consistent results provided a subtraction in certain amplitudes is introduced. However, from Regge pole theory, many of these are found to require no subtractions. Thus, whereas the current algebra and the pole-dominated dispersion relations understandably give similar results, the Regge pole theory appears to give distinctly different results. (auth)

23464 VECTOR-MESON DECAYS AND THE ALGEBRA OF FIELDS. Cordes, J. G.; O'Donnell, P. J. (Univ. of Toronto). Phys. Rev., 178: 2187-9(Feb. 25, 1969).

The three-point function $\langle 0|T\{V_\mu(x)V_\nu(y)V_\lambda(0)\}|0\rangle$ is studied in the algebra-of-fields model. By considering the most general finite smoothness expansion in q^2, p^2, and k^2, reasons can be given for the vanishing of the decays $\phi \to \rho\pi$, $\phi \to \pi^0\gamma$, $\omega \to \pi^0\gamma$, $\omega \to \rho\pi$, $\rho \to \pi\gamma$, and $\pi^0 \to 2\gamma$. Plausible ways in which these decays may be allowed without the necessity of abandoning the algebra-of-fields commutation relations are suggested. (auth)

23465 HIGH-ENERGY CONTRIBUTIONS TO CURRENT-ALGEBRA SUM RULES. I. Vasavada, Kashyap V. (Univ. of Connecticut, Storrs). Phys. Rev., 178: 2350-5(Feb. 25, 1969).

A method to evaluate high-energy contributions to current-algebra sum rules by combining them with finite-energy sum rules is suggested. Applications are made to the Adler–Weisberger-type sum rules for the π-π and the K-π systems, and to various sum rules for the pion photoproduction process. It is shown that the former sum rules can be approximately satisfied without requiring very large scalar contributions. Some interesting results are found for the latter sum rules. (auth)

23466 SPIN AND PARITY ANALYSIS FOR BOSONS DECAYING INTO SPIN-½ PAIRS. Donohue, J. T. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 178: 2288-99(Feb. 25, 1969).

An analysis is presented of the decay of a boson resonance X into two spin-½ particles, assuming parity conservation in the production and decay of particle X. The spin and parity of particle X are expressed in terms of measurable quantities, assuming that both spin-½ particles decay weakly, as in $\Lambda \to p\pi$. Two results of the analysis are that the spin determination requires measurements of the correlations between the spin-½ particles, as represented by correlations between their angular distributions, and that the odd-rank multipole tensors describing the boson spin population can be measured. In particular, the recent experimental result of Alexander et al. concerning a possible resonance in the ($\bar{\Lambda}$N) system is discussed. The measurement, while subject to large errors, suggests a large value for the L = 1, M = 1 multipole parameter. The consequences of this result for models of production mechanisms are briefly discussed. (auth)

23467 DAUGHTER SEQUENCES IN UNEQUAL-MASS VECTOR-MESON–SCALAR-MESON SCATTERING. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 178: 2302-16(Feb. 25, 1969).

The requirements of Mandelstam analyticity at zero energy are studied in unequal-mass vector-meson–scalar-meson elastic scattering. Daughter sequences of Regge poles are required, and their properties are studied. By factorization it is determined how the sequences couple to an equal-mass vector-scalar channel, and it is established that the sequences correspond to M = 0 and M = 1 Toller poles. It is how analyticity relates the slopes and second derivatives of the trajectories at t = 0 for both M = 0 and M = 1 [breaking of O(4) symmetry by nonzero energy]. The first two leading terms of the daughter residues at t = 0 [breaking of O(4) symmetry by unequal external masses and nonzero energy] are studied. The roles of factorization and the equal-mass conspiracy relation are central in the work. (auth)

23468 ZERO-MASS BOSONS IN S-MATRIX THEORY. Arbab, Farzam; Brower, Richard C. (Univ. of California, Berkeley). Phys. Rev., 178: 2470-7(Feb. 25, 1969).

The soft coupling of zero-mass bosons to other particles is described by considering the limit of a theory with a massive boson. With the standard S-matrix assumptions of analyticity and crossing for four-body helicity amplitudes, it is demonstrated generally that in the limit of zero mass, a vector boson (1^-) couples to a conserved charge and a 2^+ boson couples to the inertial mass. Bosons of other spin-parity combinations (with the exception of zero spin) have no zero-mass soft coupling. With this technique, not only a pedagogically interesting solution is given to gauge invariance and the kinematics of zero-mass particles, but new applications to small-mass integral-spin systems are suggested. Speculations are made on the application of this technique to such problems as ρ universality, the Adler–Weisberger relation, and the universality of leptonic couplings in a vector or axial-vector state. (auth)

23469 VALIDITY OF THE BALAZS METHOD. Antippa, Adel F.; Everett, Allen E. (Tufts Univ., Medford, Mass.). Phys. Rev., 178: 2443-53(Feb. 25, 1969).

A systematic study of the Balázs method, as applied to the ρ-bootstrap problem in the 2π system, is made in order to determine its validity. Inelastic effects as estimated from Regge theory are included. It is found that the method becomes well-behaved as the number of poles used to approximate the left-hand cut is increased, in contrast to results obtained previously by Bond, and that the sensitivity of the solutions to the choice of matching point may be largely eliminated by a procedure proposed by Williamson and Everett. The method predicts a ρ mass of somewhere between 680 and 760 MeV as compared to the experimental value of 750 ± 25 MeV, and a ρ half-width of about 150 MeV as compared with the experimental value of about 50 MeV. (auth)

23470 DETERMINATION OF THE DECAY COUPLING CONSTANTS AND MIXING ANGLE OF $J^P = 1^+$ MESONS. Fourez, G. (Univ. of Maryland, College Park). Phys. Rev., 178: 2454-61 (Feb. 25, 1969).

The mixing angle between the two $J^P = 1^+$ kaons (K_A and K_C) and the decay coupling constants of the A_1, B, K_A, and K_C mesons are calculated with the SU(3) × SU(3) chiral algebra. These results are used to calculate the widths of the K_A and K_C mesons, which are found to be in reasonable agreement with present experiments. The method used is the asymptotic SU(3) symmetry due to Matsuda and Oneda—i.e., the charge operator V_K, which is an SU(3) raising or lowering operator in the symmetry limit, still acts as a generator in the broken symmetry in an appropriately chosen infinite-momentum limit. For the axial charge A_π, the hypothesis of partially conserved axial-vector current is used. One uses the commutators $[V_{K^*}, A_{\pi^-}] = 0$ and $[\dot{V}_{K^*}, A_{\pi^-}] = 0$, and inserts them between the K^{*0} and A_1^+ states on the one hand and the K^{*0} and B^+ states on the other. This gives eight sum rules involving the decay coupling constants of the A_1, B, K_C, and K_A mesons, the masses of the $J^P = 1^+, 1^-$ mesons, and the mixing angle between K_C and K_A. From these sum rules and the ratio $\Gamma(A_1 \to \rho\pi)/\Gamma(B \to \omega\pi)$, the value of the mixing angle can be derived. Using the values of $\Gamma(A_1 \to \rho\pi)$ and $\Gamma(B \to \omega\pi)$, one obtains all the coupling constants and can calculate the rates of K_C and K_A decays. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 23441, 23459, and 23494.

23471 (JINR-P1-4330) STUDY OF THE JOINT RESONANCE PRODUCTION IN 4-PRONG π^+-p INTERACTIONS AT 2.34 GeV/c. Angelov, N.; Gramenitskii, I. M.; Kanazirski, Kh.; Kerachev, P.; Moiseev, A. M.; Prokesh, A.; Tikhonova, L. A.; Fenyuk, A. B.; Khristov, M.; Shafranov, M. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 16p. (In Russian). Dep.

The cross sections for the joint production of N*ρ and N*ω^0 resonances in π^+-p interactions at 2.34 GeV/c are given. The dependence of the elements of single-vertex spin density matrix on the four-dimensional transferred momentum is determined. The experimental data are compared with the calculations by the model of one-particle exchange with absorption. (auth)

23472 REGGE POLES AND POLARIZATION IN K$^-$p ELASTIC SCATTERING. Plaut, G. (Faculte des Sciences, Orsay, France). Nucl. Phys., B9: 306-14(1969).

A five Regge-pole model is presented and used to fit polarization data in K$^-$p elastic scattering between 2 and 2.4 GeV/c. Following a phenomenological analysis, solutions consistent with high-energy data are obtained and sample predictions are given for polarization in other KN scattering experiments. (auth)

23473 DETERMINATION OF REGGE-POLE RESIDUE FUNCTIONS FROM FIXED-t DISPERSION RELATIONS. Baacke, J. (Univ., Karlsruhe, Ger.). Nucl. Phys., B9: 324-30(1969).

Fixed-t dispersion relations are used to derive a simple method to determine (or test) Regge-pole residue functions from low-energy data. The method is applied to πN charge exchange scattering. (auth)

23474 DISTINGUISHING BETWEEN PERIPHERAL AND CENTRAL HIGH-ENERGY COLLISIONS. Michejda, L. (Inst. of Nuclear Research, Warsaw). Fortschr. Phys., 16: 707-18 (1968).

The idea of peripheral or central high-energy collisions is expressed in terms of partial inelastic cross sections σ_l corresponding to the initial particles being in the angular momentum state l. Various attempts to determine the total angular momentum J of the many-body states and hence also of the cross sections σ_l via the overlap function are discussed. It is shown that for the 8 GeV/cπ^+p interactions neither the uncorrelated jet model nor the multi-Regge-exchange model yield the angular momenta which would satisfy the unitarity condition of the S-matrix, unless the variable phase of the wave function is introduced. From the fact that most of the anisotropy required by the high values of J expected from the data on elastic scattering is hidden in a phase dependence, and from a study of models with variable phase, it is concluded that at the moment it is not possible to solve the question of distinguishing between peripheral and central collisions. (auth)

23475 UNIFIED STATIC BOOTSTRAP MODEL FOR EVEN- AND ODD-PARITY BARYON EXCITED STATES. Noga, M.; Cronstroem, C. (Univ. of Helsinki). Nucl. Phys., B9: 89-105 (1969).

The implications of Capps bootstrap conditions are investigated in pion- and kaon-baryon scattering in the static model. It is shown that the bootstrap conditions induce a new symmetry of the meson-baryon interaction, which gives a connection between the spin and isospin of the baryons. Using this new symmetry, a generalization of strong coupling theory is obtained for arbitrary partial wave and isospin of the mesons. The decay rates of various baryon resonances are calculated and found to be in fair agreement with experiment. (auth)

23476 POMERANCHUKON EXCHANGE PLUS DIRECT-CHANNEL RESONANCES AS A MODEL TO DESCRIBE THE ELASTIC FORWARD DIFFRACTION PEAK IN KAON-NUCLEON SCATTERING. Dikmen, F. N. (Univ. of Arizona, Tucson). Nuovo Cim., Lett., 1: 544-7(Apr. 11, 1969).

Differential cross sections for elastic K$^+$p interactions at 120 to 14.88 GeV/c and K$^-$p interactions at 0.740 to 15.91 GeV/c are analyzed using the model of Pomeranchuk exchange plus direct channel resonances. (L.B.S.)

23477 BACKWARD π-p ELASTIC SCATTERING AND A MODIFIED INTERFERENCE MODEL. Minami, S.; Sasaki, K.; Shigeta, K. (Osaka City Univ.). Nuovo Cim., Lett., 1: 531-6 (Apr. 11, 1969).

Backward π-p elastic scattering at 1.5 to 5 GeV/c is studied using the modified interference model that takes into account the locally averaged value of the resonant amplitude. It is found that the observed structure of both $\pi^+ - p$ and $\pi^- - p$ elastic scattering at 180° can be well explained by the model. It is also shown that the sharp minimum in $d\sigma/d\Omega$ (180°) for $\pi^+ - p$ elastic scattering at about 2 GeV/c can be reproduced without the assumption of an additional resonance (D_{35} (2250)) with $I = 3/2$ and negative parity. (L.B.S.)

23478 AVAILABLE DATA ON SPIN EFFECTS IN HIGH ENERGY SCATTERING. Bellettini, G. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy). pp 1-21 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967. See CONF-671079.

Various Regge pole descriptions of polarization data on π^-p charge exchange and $\pi^\pm$p and pp elastic scattering up to 12 GeV/c are reviewed. Some new data recently reported on $\bar{p}$p and K$^-$p interactions at ~2.5 GeV/c, as well as some information on the polarization in the reaction $\pi^- + p \rightarrow \eta + n$ at 12 GeV/c, are also reviewed. (L.B.S.)

23479 THE CLASSICAL LIMIT OF FOURTH ORDER MATRIX ELEMENTS FOR MESON NUCLEON SCATTERING USING PSEUDOSCALAR-PSEUDOSCALAR COUPLING THEORY. Capener, Robert Lee. Seattle, Univ. of Washington, 1968. 86p. Thesis.

The matrix elements for the scattering of pseudoscalar mesons from nucleons using a pseudoscalar interaction has been calculated to fourth order using Heitler's expression for the compound matrix elements. The classical limit of these matrix elements was taken using the technique developed by Chatelain and an examination made of their convergence properties. These calculations have been compared to those of Page made for the case of a pseudoscalar meson interacting with nucleons by a pseudovector coupling. It has been shown that the ps-ps coupling does not lead to finite matrix elements in the classical limit. (Diss. Abstr.)

23480 POMERANCHUK EXCHANGE AND MULTI-PION PRODUCTION. Satz, H. (CERN, Geneva). Phys. Lett., 29B: 38-40(Mar. 31, 1969).

A simple test for Pomeranchuk exchange dominance in multipion production is obtained from isospin relations and used to show that present production data are not compatible with this assumption. (auth)

23481 ELEMENTARY DERIVATION OF INTERMEDIATE-COUPLING AND STRONG-COUPLING MASS FORMULAS FOR THE NONRELATIVISTIC LEE MODEL. Nickle, H. H. (Duke Univ., Durham, N. C.). Contract DA-31-124-AROD-13. Nuovo Cim., 60A: 614-20(Apr. 21, 1969).

It is pointed out that in both Tomonaga's intermediate-coupling approximation and North's strong-coupling approximation, the Hamiltonian can be written as the sum of two commuting operators, Q and K, each of which also commutes with the Hamiltonian. Furthermore, it is shown that $K^2 = -Q + \text{const}$, where Q is the total-charge operator for the meson-nucleon system (and consequently its eigenvalues are known). Hence both the strong-coupling and intermediate-coupling approximations lead to the same type of "mass formula." (auth)

23482 $\omega-\rho$ INTERFERENCE WITH THE ABSORPTIVE PERIPHERAL MODEL. Baracca, A. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cim., 60A: 633-42(Apr. 21, 1969).

The problem of the $\omega-\rho$ interference in the reaction $\pi^-p \rightarrow e^+e^-n$ at 1.65 GeV/c is studied using the peripheral model with absorptive corrections. (auth)

23483 DOUBLE REGGE MODEL AND AN ANTICORNERING EFFECT IN THREE-PARTICLE PRODUCTION PROCESSES. Ranft, G. (Rutherford High Energy Lab., Chilton, Eng.). Nuovo Cim., 60A: 643-50(Apr. 21, 1969).

It is shown that in some cases the application of the double Regge model to low invariant masses of the final particles as proposed by Chew and Pignotti leads to an "anticornering" in the Dalitz plot. This effect shows up in the theoretical invariant-mass distributions, which can be very different from the ones obtained by application of the double Regge-model to high invariant masses only. This anti-cornering effect is seen in the reaction $\pi^-p \rightarrow \pi^-\pi^+n$ at 11 GeV/c. (auth)

23484 PION PRODUCTION IN THE PHENOMENOLOGICAL CHIRAL LAGRANGIAN MODEL. Dutt, R.; Nanda, P. (Univ. of Delhi). Nuovo Cim., 60A: 706-12(Apr. 21, 1969).

The low-energy pion-production cross section in pion-nucleon collisions was studied within the framework of phenomenological chiral Lagrangian model which incorporates algebra of currents and PCAC. Predicted production cross section below 290 MeV shows good agreement with experiment. The present calculation was compared with the soft-pion current-algebra result and departure from PCAC in this model was discussed. (auth)

23485 DECAY WIDTH, MAGNETIC MOMENTS, AND TRANSITION MOMENT OF NUCLEON ISOBARS FROM ALGEBRA OF CURRENTS. Pattnaik, M. (Saha Inst. of Nuclear Physics, Calcutta). Nuovo Cim., 60A: 555-74(Apr. 21, 1969).

Using the equal-time commutation relations of axial vector current-current and current-magnetic moment operators, sum rules for the reduced matrix elements of these operators are obtained. These sum rules correspond to a set of an infinite number of coupled equations which are solved by truncating the intermediate states at various stages. A systematic study was made to examine how quantities like axial vector renormalization constant, decay width of $N^*(1238)$, ratio of $(N^{*(+)}N^{*(+)}\pi^{(0)})$ to $(NN\pi)$ couplings, magnetic moments of nucleon isobars, and the transition moments of nucleon to $N^{*(+)}$, vary with truncations. It is also noticed that if one truncates the states in a particular fashion, results normally ascribed to higher symmetry groups are reproduced. Over and above it is found that if all the diagonal states I = J are retained, the sum rules yield a N^* width equal to 125 MeV and the transition moment $\langle p|M_3|N^{*(+)}\rangle = 1.25\ (2\sqrt{2}/3)\ \mu(p)$, compared with the experimental values 120 MeV and $(1.28 + 0.02)(2\sqrt{2}/3)\mu(p)$ respectively. (auth)

23486 HYPOTHESIS OF M1 DOMINANCE IN $^3\!/_2{}^+$-ISOBAR PRODUCTION REACTIONS. Renninger, G. H.; Sarma, K. V. L. (Carnegie–Mellon Univ., Pittsburgh). Phys. Rev., 178: 2201-10 (Feb. 25, 1969).

The hypothesis that the $\rho N\Delta$ and $A_2N\Delta$ vertices are predominantly of the magnetic-dipole (M1) type is investigated in detail with reference to the $^3\!/_2{}^+$-isobar production reactions at high energies. The incorporation of this hypothesis for the Regge exchanges of ρ and A_2 mesons is greatly facilitated by our choice of Reggeizing the invariant amplitudes, a choice which avoids spurious parametrizations of the unknown Regge residues and which automatically satisfies all the constraint conditions at the normal thresholds and pseudothresholds. The simple model which assumes only M1 couplings and SU(3) symmetry at the Regge vertices is in satisfactory agreement with the available high-energy data on the differential cross sections and density matrix elements of the reactions $\pi^+p \rightarrow \pi^0(\eta)\Delta^{2+}$, $\pi^-p \rightarrow \pi^-\Delta^+$, and $K^+p \rightarrow K^0\Delta^{2+}$. The presence of a small E2 coupling at the vector-meson vertex, in addition to the dominant M1 coupling, is shown to provide an improved fit with experiment near the forward direction. (auth)

23487 STUDY OF SCATTERING AMPLITUDES WITH REGGE POLES ONLY. Sertorio, Luigi; Wang, Ling-lie (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 178: 2462-70(Feb. 25, 1969).

A study is made of the idea, recently emphasized, that crossed-channel Regge poles only can well express a given amplitude not only asymptotically but also at any energy. The present study is a phenomenological one and the reaction examined is πN charge exchange. All leading Regge trajectories which have been found by previous research to be necessary for accurate agreement with the data (namely, Δ, N, ρ,ρ') are introduced. In order to cover the region for which there is no detailed knowledge of Regge-pole parameters, the assumption is made that trajectories are straight lines. Special care is taken in discussing the residues which are the most relevant quantities. The α factors included in the residues are discussed in some detail. The various possible choices of α factors are effective both on the s-channel Argand diagrams and also in providing the resonance dip and bump structures in $d\sigma/dt|_{t=0}(\pi^-p \rightarrow \pi^0n)$ and $\sigma_{\text{total}} = \sigma(\pi^-p) - \sigma(\pi^+p)$. Throughout the calculations, exact formulas are always used. Finally, the result of a similar study of the elastic πp reactions is discussed. (auth)

23488 $\pi\Lambda$ PHASE-SHIFT INFORMATION FROM HIGH-ENERGY ANTINEUTRINO REACTIONS AND FROM Ξ_{e4} DECAYS. Pais, A. (Rockefeller Univ., New York); Treiman, S. B. Phys. Rev., 178: 2365-72(Feb. 25, 1969).

Methods are described to obtain the S-wave $\pi\Lambda$ phase shift from the processes $\Xi \rightarrow \Lambda\pi e\bar{\nu}$ and $\bar{\nu} + N \rightarrow \Lambda\pi\bar{\mu}$. Each of these processes is fully specified (for vanishing lepton mass) by a set of sixteen seven-dimensional distributions describing the intensity and the various polarization spectra. From each distribution, nine functions of a single variable, the invariant $\pi\Lambda$ mass, are extracted. Ratios of these functions determine the S-wave phase shift, for energies where only S- and P-wave amplitudes are appreciable and where the S phase shift is the only significant one. For the decays there are 36 independent determinations of this kind. For the reactions there are 8 and these are independent of a detailed knowledge of the incoming $\bar{\nu}$ spectrum. In all instances, knowledge of the polarizations of the parent baryon and of the Λ is indispensable. No assumptions on the structure of hadronic form factors are necessary. It is assumed that possible deviations from lepton pair locality and from T invariance are insignificant. (auth)

23489 DIP MECHANISMS AT J = −1. Lang, J. E. (Univ. of Illinois, Urbana). Phys. Rev., 178: 2380-1(Feb. 25, 1969).

Possible dip mechanisms at J = −1 are discussed and then applied to the case of πN charge-exchange scattering. (auth)

23490 REGGE POLES WITH ABSORPTIVE-CORRECTION CUTS AND EXCHANGE DEGENERACY IN THE REACTION $\pi^-p \rightarrow \eta n$. Blackmon, Maurice L. (Argonne National Lab., Ill.). Phys. Rev., 178: 2385-6(Feb. 25, 1969).

A Regge-pole model with absorptive corrections is used to fit the differential cross sections for the reaction $\pi^-p \rightarrow \eta n$. This model, unlike the pure Regge-pole A_2-exchange model, also predicts a nonzero polarization. Exchange degeneracy is assumed for residues and trajectory. Thus, previous work on πN scattering and KN scattering is used to fix the trajectory of the A_2 and its residue functions. SU_3 is also used to determine the size of the residues. Only a small amount of SU_3 breaking (10%) is needed to fit the data. (auth)

23491 LOW-ENERGY $\bar{K}N$ SCATTERING AND FINITE-ENERGY SUM RULES. Logan, R. K.; Raxmi, M. S. K. (Univ. of Toronto). Phys. Rev., 178: 2240-3(Feb. 25, 1969).

Finite-energy sum rules are used to test the consistency of Kim's multichannel effective-range analysis of low-energy $\bar{K}N$ data with high-energy total cross sections. (auth)

23492 CALCULATION OF THE COUPLING CONSTANTS $g_{\Lambda KN}{}^2$ AND $g_{\Sigma KN}{}^2$ USING KAON-NUCLEON DISPERSION RELATIONS. Rogers, Terence W. (Univ. of California, Berkeley). Phys. Rev., 178: 2478-83(Feb. 25, 1969).

Forward kaon-nucleon dispersion relations are used to determine whether the known energy dependence of the low-energy Kp elastic scattering amplitude uniquely and consistently prescribes the coupling constants $g_{\Lambda K^-p}{}^2$ and $g_{\Sigma^0K^-p}{}^2$. In one application, the consistency of the multichannel effective-range continuation below the physical threshold is checked by calculating the coupling constants over a range of energies. In the second application, a theorem which places bounds on the energy dependence of certain types of unknown dispersion integrals is used to find bounds on the coupling constants. (auth)

23493 LOW-ENERGY THEOREMS FOR PION–NUCLEON SCATTERING FROM DISPERSION RELATIONS AND CROSS SYMMETRY. Kottler, H.; Willey, R. S. (Univ. of Pittsburgh). Contract AT-30-1-3829. Phys. Rev., 178: 2146-53(Feb. 25, 1969).

Low-energy theorems are derived for pion-nucleon scattering from dispersion relations and crossing symmetry. The presence of low-lying pion-nucleon resonances is taken into account. The relations obtained are different from the low-energy theorems obtained from current algebra and the hypothesis of partially conserved axial-vector current. (auth)

Strong (Baryon No. ≥ 2)

23494 COHERENT INELASTIC INTERACTIONS OF HIGH ENERGY π MESONS WITH ATOMIC NUCLEI. Wysotzki, F. Monatsber. Deut. Akad. Wiss. Berlin, 10: 769-76(1968). (In German).

Some studies on the coherent production of a 3-pion state by primary pions with energies ≥ 6 GeV, i.e., the process π + nucleus → nucleus + 3π, were reported. The theory of the coherent inelastic interactions was given and compared with the experimental results on diffraction decay. The distributions of the invariant masses were determined. The coherent one-pion exchange was described more accurately by the off-the-shell effect than by the EPA model. (J.S.R.)

23495 NEUTRON–PROTON RADIUS DIFFERENCE AND PION PRODUCTION BY PROTONS ON NUCLEI. Hirt, W. (CERN, Geneva. Eidgenoessiche Technische Hochschule, Zurich). Nucl. Phys., B9: 447-50(1969).

The Margolis model for pion production on nuclei is extended in order to include a possible difference between the neutron and proton rms radii. Its application to experimental results suggests that the neutron radius in Pb is ≈0.6 fm larger than that of protons. (auth)

23496 DISTRIBUTION OF HIGH-ENERGY PARTICLES SCATTERED BY A PLANE. Durand, Alain (Univ., Rennes, France). Compt. Rend., Ser. A, B, 268: 309-12(Jan. 27, 1969). (In French).

The angular and spatial distribution of particles scattered by a plane is analyzed in the approximation of small angles and negligible energy loss. (J.F.P.)

23497 EFFECT OF THREE-BODY ΛNN INTERMEDIATE-RANGE POTENTIAL IN LIGHT HYPERNUCLEI AND IN NUCLEAR MATTER. Loiseau, B. A. (McMaster Univ., Hamilton, Ont.). Nucl. Phys., B9: 169-93(1969).

Effects of the three-pion exchange ΛNN force P on the binding energies of ${}_{\Lambda}^{3}H$, ${}_{\Lambda}^{5}He$ and nuclear matter are examined and compared with those previously obtained using the two-pion exchange ΛNN force W_p. The force P is derived in the static approximation. Since the short-range part of the ΛNN force is not known, P is taken to be zero for Λ-N distances less than a cutoff distance $d_{\Lambda N}$. The magnitude of the results, but not their sign, is found to be sensitive to $d_{\Lambda N}$. In ${}_{\Lambda}^{3}H$, P is found to be attractive; for $d_{\Lambda N} \approx 1$ fm the contribution of P is greater than that of W_p, although the overall effect $(P + W_p)$ is still relatively small and is attractive. The force P is found to further reduce the binding energy of ${}_{\Lambda}^{5}He$; for $d_{\Lambda N} \approx 1$ fm P only slightly modifies the results obtained using W_p alone. In nuclear matter the contribution of P is found to be repulsive and greater than that of W_p; even for $d_{\Lambda N} \approx 1$ fm the overall effect $(P + W_p)$ is found to be larger and is repulsive. (auth)

23498 GLAUBER SERIES INTERPRETATION OF SCATTERING DATA. Kofoed-Hansen, O. (CERN, Geneva). Nuovo Cim., 60A: 621-32(Apr. 21, 1969).

The Glauber theory of high-energy collisions is used in a discussion of the scattering of composite bodies. The scattering amplitude is developed as a multiple-scattering series, and it is shown that conclusions drawn on the basis of truncated versions (e.g., inclusion of up to triple scattering only) of such series should be viewed with extreme caution. Because of ease of computation a model of Gaussian density distributions and profile functions is considered in detail and applied to the prediction of the $\alpha-\alpha$ elastic cross-section and to a discussion of "quark" model interpretation of the p-p elastic cross-section. Nothing in the results can be interpreted as a special support for the ordinary quark model; mere multiplicity is what counts. (auth)

23499 ANALYSIS OF THE 95-MeV PROTON–PROTON SCATTERING DATA. Signell, Peter; Miller, M. D. (Michigan State Univ., East Lansing). Phys. Rev., 178: 2377-9(Feb. 25, 1969).

The new Harwell data are found to reduce most of the 95-MeV phase-shift uncertainties by moderate amounts, but the important and poorly known ${}^3P_0$ phase shift is not affected significantly. A precise measurement of spin depolarization is found to be the only single experiment which would properly delineate this phase shift. (auth)

23500 MULTIPLE-SCATTERING CALCULATION OF THE K^--LIGHT NUCLEUS SCATTERING LENGTHS. Seki, R. (Univ. of Denver). Phys. Rev., 178: 2316-22(Feb. 25, 1969).

The K^--d, -t, -^{3}He, and -^{4}He scattering lengths were calculated using the multiple-scattering theory with Kim's zero-range K-nucleon scattering lengths. The results are in agreement with the K^--^{4}He scattering experiment and with the three-body calculation of the K^--d scattering length, but not in good agreement with the K^--^{4}He mesonic-atom experiment. (auth)

23501 BROAD-AREA SUBTRACTION DISPERSION RELATION FOR FORWARD pp SCATTERING. Liu, Yu-chien (Univ. of Rochester, N. Y.). Phys. Rev., 178: 2243-5(Feb. 25, 1969).

Dispersion relations in which the real part of an amplitude appears in a finite range of the dispersion integral are studied, particularly for forward pp scattering. Lindenbaum's measurement of $\alpha \equiv \mathrm{Re}C_{pp}(\nu)/\mathrm{Im}C_{pp}(\nu)$ is tested. (auth)

23502 HIGH-ENERGY pp SCATTERING AND HADRONIC STRUCTURE OF THE PROTON. Islam, M. M. (Univ. of Connecticut, Storrs); Rosen, Joe. Phys. Rev., 178: 2135-40(Feb. 25, 1969).

Present high-energy large-angle pp angular distribution in the momentum range 8 to 21 GeV/c is investigated using an optical-model description. Observed differential scattering cross sections can be explained in terms of two hadronic distributions of the proton and Lorentz contraction of the distributions. It is inferred that these distributions interact by exchanging vector mesons: ω, and a new one, ω', having the same quantum numbers as ω. (auth)

23503 HADRONIC AND ELECTROMAGNETIC STRUCTURE OF THE PROTON. Islam, M. M.; Vasavada, Kashyap V. (Univ. of Connecticut, Storrs). Phys. Rev., 178: 2140-3(Feb. 25, 1969).

Vector-meson–nucleon form factors obtained from high-energy, large-momentum-transfer pp scattering are used to determine the proton magnetic form factor $G_{Mp/\mu p}$. With essentially one adjustable parameter, all present large-momentum-transfer data can be fitted. The neutron magnetic form factor $G_{Mn/\mu n}$ is predicted and is found to have a zero at $\Delta^2 \approx 2.0$ $(GeV/c)^2$. (auth)

23504 IMPLICATIONS OF THE OPTICAL MODEL FOR THE S-MATRIX APPROACH TO HIGH-ENERGY pp SCATTERING. Islam, M. M. (Massachusetts Inst. of Tech., Cambridge. Univ. of Connecticut, Storrs). Phys. Rev., 178: 2144-5(Feb. 25, 1969).

The optical model is shown to indicate that the high-energy large-momentum-transfer pp elastic scattering amplitude obeys the Mandelstam representation and that the corresponding absorptive parts and double spectral functions are highly oscillatory. (auth)

23505 GLAUBER CORRECTIONS AND INTERACTION BETWEEN HIGH ENERGY HADRONS AND NUCLEI. Gribov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 56: 892-901(Mar. 1969). (In Russian).

It is shown that the screening effect which plays an important role in the interaction between hadrons and nuclei markedly changes for hadron momenta exceeding $p_0 \sim 5 + 10$ BeV/c. For momenta $p < p_0$ the screening is mainly determined by elastic rescattering and for $p > p_0$ mainly by absorption of particles produced in inelastic collisions. This change in the physics of screening processes for $p > p_0$ may result in the variation of the total scattering cross sections on light nuclei. At ultra high energies this change in the nature of the screening leads to the result that even if the cone in elastic processes does contract due to motion of the Pomeranchuk pole, the total cross section for interaction between hadrons and nuclei should be proportional to $A^{2/3}$ where A is the number of nucleons in the nucleus. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 23530 and 23778.

23506 ABOUT O'RAIFEARTAIGH'S THEOREM. Fuchs, Gerard (Ecole Polytechnique, Paris). Ann. Inst. Henri Poincare, Sect. A, 9: 7-16(1968).

A study is made of a conjecture that any semi-simple Lie algebra G having Poincaré as a subalgebra also contains a dilatation (that is, an element commuting with the Lorentz generators and having the translation generators for eigenvectors). It is shown that the conjecture, which would have given a result somewhat more precise than O'Raifeartaigh's theorem and of purely algebraic nature, is not true. A rule is given to construct counterexamples of arbitrarily high dimension for any type of algebra. (J.F.P.)

23507 SIMPLE DERIVATION OF EQUAL SPACING RULE IN MASSES IN DECUPLET BY CURRENT COMMUTATORS. Bose, Subir Kumar (Indian Inst. of Tech., Kanpur). Acta Phys. Acad. Sci. Hung., 25: 321-3(1968).

The equal spacing rule is derived for masses in the decuplet neglecting electromagnetic splittings compared to splittings between the I-spin multiplets. (J.F.P.)

23508 UNITARY-SYMMETRICAL THEORY OF MULTIPLE-PARTICLE PRODUCTION. Barashenkov, V. S.; Zinovev, G. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Fortschr. Phys., 16: 719-36(1968).

A statistical approach is formulated which takes into account the unitary symmetry of strong interactions. The unitary symmetrical statistical theory of multiple particle production is considered in detail. Approximations used in this model are given, and the calculation is described. Results of calculating different characteristics of inelastic interactions are sketched. (J.F.P.)

23509 GROUP ANALYSIS OF SCATTERING AMPLITUDES. THE GROUP SU(1,1). Balachandran, A. P. (Syracuse Univ., N. Y.); Nuyts, J. Nucl. Phys., B9: 81-8(1969).

An expansion for scattering amplitudes involving four particles of equal mass is proposed. It displays the dependence of the amplitude on all the Mandelstam variables and is intimately related to the Kotánski expansion in terms of transversity amplitudes. (auth)

23510 TYPES OF THE ELEMENTARY PARTICLES. Goldberg, H (Tel Aviv Univ., Israel). Nuovo Cim., 60A: 509-18 (Apr. 21, 1969).

The full quantum-mechanical Poincaré group is defined as the one obtained by "enhancing" the restricted (connected) quantum-mechanical Poincaré group with the three discrete operations (rather than the two discussed by Wigner) of space inversion, time reversal and charge conjugation. Ray corepresentations of these reflections are discussed, and 16 types are found. The assignment of types to the various elementary particles is discussed. (auth)

23511 UNITARY SYMMETRY. Gasiorowicz, S. G. (Univ. of Minnesota, Minneapolis); Glashow, S. L. Contracts ONR 3656-09; AT(11-1)-1371. Advan. Theor. Phys., 2: 1-73(1968).

The discussion of unitary symmetry covers representations of SU(3), strong interactions, electromagnetism and SU(3), weak interactions, and speculations on the origins of and departures from the eightfold way. (J.F.P.)

Applications (Electromagnetic and Weak)

Refer also to abstract 23522.

23512 A NON-LINEAR REALISATION OF SU(3) ⊗ SU(3). Dietz, K. (Univ., Heidelberg. Univ., Bonn); Honerkamp, J. Z. Phys., 22: 46-57(1969).

A nonlinear SU(3) ⊗ SU(3) invariant Lagrangian is constructed. The nonlinear transformations are required to be linear only on the subgroup of isospin rotations and strangeness gauges: π, K, η, and κ-mesons appears as goldstone bosons; masses of vector- and axialvector, as well as strange and nonstrange, Yang-Mills field are split. Results predicted by this SU(3) ⊗ SU(3) invariant Lagrangian are similar to those obtained previously by Ward-identity techniques, however, no assumption on symmetry breaking has to be made. The K_{l3} formfactors are discussed. (auth)

23513 FORM FACTOR AND MASS CORRECTIONS TO WEAK DECAY AMPLITUDES. Barut, A. O.; Malin, S. (Univ. of Colorado, Boulder). Nucl. Phys., B9: 194-200(1969).

The composite relativistic O(4.2) model of baryons and mesons that gives correct electromagnetic form factors and mass spectra is extended to weak currents. It is then possible to calculate the corrections due to mass differences and due to form factors in weak decays. These corrections can amount to as much as 20%. An internal symmetry cannot hold to a better accuracy than this in the framework of a dynamical group. It is shown that when these corrections are incorporated into the Lee-Sugawara triangle, the experimental ambiguity in the s- and p-wave decay amplitudes of Σ_0^+ cannot be removed on theoretical grounds. (auth)

23514 CURRENT ALGEBRA, INFINITE MOMENTUM, AND SUM RULES. Matsuda, S. (Univ. of Toronto); Oneda, S. Nucl. Phys., B9: 55-66(1969).

Results obtained so far by using an approximation called SU(3) approximation and a chiral SU(3) ⊗ SU(3) charge-charge or charge-charge density algebra are summarized. The approximation concerns the vector charge operator V_K which is an SU(3) raising and lowering operator in the symmetry limit. It is assumed that even in broken symmetry the operator V_K still acts as a generator, to a good approximation, in an appropriately chosen infinite momentum limit. Many broken SU(3) coupling constant sum rules are derived as well as the first SU(3) and the first chiral SU(2) ⊗ SU(2) spectral function sum rules. The inclusion of the time derivative of the operator V_K in this approach allows not only the SU(3) mass formulas to be derived but also the SU(6)-like intermultiplet mass formulas and the sum rules involving the masses and physical coupling constants that agree rather well with experiment. (auth)

23515 POSSIBLE ORIGIN OF THE CP VIOLATION IN THE NEUTRAL K SYSTEM. Yun, Suk Koo (Syracuse Univ., N. Y.). Phys. Rev., 178: 2439-42(Feb. 25, 1969).

The observed CP nonconservation in the neutral K system is assumed to be the manifestation of the CP violation through the mass operator, as well as the CP-violating interaction $H_\gamma^{(-)} H_w^{(+)}$ composed of the effective CP-violating second-order electromagnetic interaction and the CP-conserving weak interaction. This assumption, coupled with the vector- and scalar-meson dominance, seems to produce a set of reasonable predictions. The results are compared with the superweak model. (auth)

23516 CAN INFINITE MULTIPLETS BE INFERRED FROM THE WEAK DECAY RATES? Boehm, A.; Sudarshan, E. C. G. (Syracuse Univ., N. Y.). Phys. Rev., 178: 2264-73(Feb. 25, 1969).

An algebraic model B describing symmetry breaking, which was considered in a previous paper for the mass spectrum problem, is applied to the weak decays K_{l3}, K_{l2}, π_{l3}, and π_{l2}. It gives constant form factors, $\xi = 1$, and a suppression of the strangeness-changing decays (Cabibbo angles) of $S_{l2} = 0.28$ ($\tan\theta_A^M$) and $S_{l3} = 0.18$ ($\tan\theta_V^M$). The results also allow the determination of all parameters that characterize the representation of B and its spectrum-generating group SL(3,c), from which the infinite dimensionality of the multiplets can be inferred. (auth)

23517 CALCULATION OF THE K_{l3} FORM FACTORS. Barut, A. O. (International Centre for Theoretical Physics, Trieste, Italy); Tripathy, K. C. Phys. Rev., 178: 2278-83(Feb. 25, 1969).

The K_{l3} form factors $f_\pm(t)$ were determined in a model of strong interactions based on the rest-frame group O(4,2) ⊗ SU(3). Using the values of the parameters determined from the boson-mass spectrum and pion electromagnetic form factor, at $t = t_0 = (m_K - m_\pi)^2$, $\xi(t_0) \cong (m_K - m_\pi)/(3m_K - m_\pi) = 0.27$ was obtained. The validity of exact SU(3) symmetry for the rest-frame states was then tested. The condition $f_+^K(t_0) = \frac{1}{2} f_+^\pi(t_0)$ yields $\lambda_+ = 0.0152$, $\lambda_- = 0.199$, and $\xi(0) = 0.097$, in agreement with the latest experimental values. (auth)

23518 DETERMINATION OF Reϵ FROM MEASUREMENTS OF THE LEPTONIC DECAYS OF LONG-LIVED NEUTRAL KAONS. Ginsberg, Edward S. (Univ. of Massachusetts, Boston). Phys. Rev., 178: 2484-5(Feb. 25, 1969).

The recent measurement of the charge asymmetry δ is combined with data on the decay rates in K_{e3} decays to yield a value of Reϵ, the CP-violating overlap of K_L and K_S. (auth)

23519 η ASYMMETRY WITHOUT C NONCONSERVATION. Kabir, P. K. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., 178: 2486(Feb. 25, 1969).

Interference asymmetry should be greatly reduced in situations where isospin selection rules forbid the occurrence of I = 2 background. (auth)

23520 SU(3) SYMMETRY BREAKING AND THE CABIBBO ANGLE. Matsuda, S. (Univ. of Toronto); Oneda, S.; Desai, P. Phys. Rev., 178: 2129-35(Feb. 25, 1969).

An attempt is made to determine the Cabibbo angle without assuming the validity of exact SU(3) symmetry. A weaker assumption is used, namely that the renormalization of the SU(3) raising and lowering operator V_K due to the SU(3)-breaking interaction at the zero-momentum-transfer limit is small and negligible compared with other SU(3)-breaking effects which appear in the mass splitting, mixing, and physical coupling constants. Combined with the use of the chiral SU(3) ⊗ SU(3) charge algebra, this approximation [called the SU(3) approximation] leads to a set of sum rules for the axial-vector coupling constants of semileptonic decays of hyperons. By using these sum rules, the Cabibbo angle is computed from some of the latest experiments on the $\Lambda \to p$, $\Sigma \to \Lambda$, and $n \to p$ leptonic decays. One of the important effects of the electromagnetic corrections; namely, the effect of π^0-η^0 and Σ^0-Λ^0 electromagnetic mixing is discussed. By using the pion partially conserved axial-vector current hypothesis, the SU(3) approximation also leads to generalized Goldberger–Treiman relations which give information on the pion-baryon couplings. (auth)

Applications (Strong)

23521 DECAYS OF BARYON RESONANCES IN AN O(3.1) MODEL. Hamprecht, B. (Univ. of Colorado, Boulder); Kleinert, Hagen. Fortschr. Phys., 16: 635-68(1968).

The notion of dynamical groups has been introduced into hadron physics in order to relate amplitudes of particles of many different spins. In particular the O(3.1)-model of Barut and Kleinert gives the pseudoscalar form factors of all the strange and nonstrange baryons in terms of a few adjustable coupling constants and claims that they furnish a good approximation in the region of not too large physical momentum transfers. An extensive comparison of this O(3.1)-model with experimental information is reported. For one such comparison the known partial decay widths of baryon resonances into members of the nucleon and pseudoscalar meson octet are taken. The fit obtained is quite good and the SU(3) symmetry breaking is described in much better agreement with experiment than in an approach which, instead of O(3.1)-form factors, takes only the correct threshold behavior into account. Further baryon decays with two final mesons are examined, and theoretical Dalitz-plots are calculated. Very good agreement with some recent results on $\Delta(1920) \to \Delta K\pi$ is achieved. Finally some closed functional form is given for the form factors which approximate the complicated O(3.1) form factors well in the region relevant for phenomenological calculations. (auth)

23522 SPONTANEOUS SU_3 BREAKING. Cabibbo, N. (Univ., Rome. CERN, Geneva). pp 62-72 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

A possible approach to the problem of symmetry breaking with electromagnetic and weak interactions is discussed such that problems concerning the relative orientations of different symmetry breakings are solvable. The approach considered is one in which one assumes that strong interactions are indeed SU(3) symmetric, but that the strength of the interactions renders the symmetric solutions unstable so that there is a spontaneous breakdown of the symmetry. (J.F.P.)

23523 GENERALIZED U(6) x U(6) KINEMATICAL TRANSFORMATIONS AND PROPERTIES OF 2^+ MESONS. Chang, Shau-jin (Harvard Univ., Cambridge, Mass. Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 178: 2421-6(Feb. 25, 1969).

Schwinger's comparative kinematical transformations are generalized to include semilocal transformations. By identifying the 2^+ mesons as bound states of two fundamental Dirac fields ψ through $h_{\mu\nu} \sim \bar{\psi}\gamma_\mu\partial_\nu\psi$, various trilinear meson-meson interactions among 2^+ mesons and 0^- and 1^- mesons are obtained. The agreement between the theoretical predictions and the experimental measurements for various decay widths is satisfactory. (auth)

23524 BARYON SUPERMULTIPLETS OF SU(6) x O(3) IN A QUARK–DIQUARK MODEL. Lichtenberg, D. B. (Rutherford Lab., Chilton, Eng.). Phys. Rev., 178: 2197-2200(Feb. 25, 1969).

A model in which a baryon is a bound state of a quark and diquark is used to obtain a classification of baryon resonances according to a broken SU(6) × O(3) scheme. If the interaction between quark and diquark has an appreciable space-exchange contribution, a level ordering is obtained which is consistent with the present experimental information. The results are compared to those obtained with other models. (auth)

Field Theories

General

23525 A NEW ENERGY MOMENTUM TENSOR OF THE KLEIN–GORDON FIELD. Gerlach, Bernd; Gromes, Dieter; Petzold, Joachim (Univ., Marburg, Ger.). Z. Phys., 222: 191-200(1969). (In German).

The interpretation of the Klein–Gordon tensor as an energy–momentum tensor turns out to be physically inconsistent. Therefore, a different tensor is proposed. (auth)

Quantum Field Theory

Refer also to abstracts 23340, 23409, and 23550.

23526 (LNF-69/1) SOME REMARKS ON Q. E. D. BREAKING. Note No. 424. Grillo, A. F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Jan. 3, 1969. 17p. Dep.

The breakdown of quantum electrodynamics is considered in colliding beam experiments. The possibility that the electron does not behave like a point particle is examined attributing to it a magnetic as well as an electric form factor. The reaction $e^+ + e^-$ is discussed. Also the consequences of modifying the photon propagator are examined. (J.F.P.)

23527 A DOUBLE REGGE MODEL OF PRODUCTION PROCESSES. Kosterlitz, J. M. (Oxford Univ.). Nucl. Phys., B9: 273-85(1969).

The Feynman diagram method is used to calculate the amplitude for a bi-Regge pole exchange for multiparticle production processes at very high energies. The two cases of normal and abnormal coupling at the Reggeon-Reggeon-particle vertex are considered. Certain differential cross sections are evaluated and compared to previous results. (auth)

23528 ASYMMETRICAL PAIR PRODUCTION IN QUANTUM ELECTRODYNAMICS WITH MODIFIED FERMION PROPAGATOR. Fraas, H. (Univ., Wuerzburg, Ger.). Nucl. Phys., B9: 433-40 (1969).

One- and two-photon vertices are constructed which restore gauge-invariance of the amplitude for pair production in QED with modified fermion propagator. By means of the modified Bethe–Heitler cross section, the sensitivity of asymmetrical pair production against a modification of the fermion propagator is discussed and compared with that of wide-angle production of symmetrical pairs. (auth)

23529 GENERALIZED FIELD QUANTIZATION PROCEDURES. Geyer, B. (Karl-Marx-Univ., Leipzig). Nucl. Phys., B9: 67-74(1969).

It is shown that a quantization procedure given by Parks is either identical with the method of Roman and Aghassi or with an obvious alteration of the para field theory depending on the definition of the number operator. Next, by an appropriate change of the para commutation relations for the creation and annihilation operators a whole set of such theories are defined which includes the para field theory themselves and the method of Parks. However, by the requirement of unitary invariance of the corresponding commutation relations all these theories except the para field theory may be ruled out. (auth)

23530 SYMMETRY OPERATIONS AND SPONTANEOUSLY BROKEN SYMMETRIES IN RELATIVISTIC QUANTUM FIELD THEORIES. Reeh, Helmut (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Fortschr. Phys., 16: 687-706 (1968).

A discussion is presented on some properties of symmetry operations in connection with the spontaneously broken symmetries in relativistic quantum field theory. This discussion covers symmetry operations, one-parameter continuous symmetry operations, spontaneously broken symmetries, and the connection with global observables. (J.F.P.)

23531 INTERACTIONS OF PHOTONS AND LEPTONS WITH MATTER. Roy, R. R.; Reed, Robert D. New York, Academic Press, Inc., 1968. 328p. $14.50.

A survey is given of current concepts and interpretations of quantum electrodynamics. A unified treatment of interaction phenomena involving photons, leptons, and matter is presented with particular attention given to high-energy electron and meson (μ) interactions. The use of the Hamiltonian method permits a logical formulation of the theory. A detailed account of the application of this method to the anomalous magnetic moment of the electron and the Lamb shift is presented. (J.F.P.)

23532 RELATIVISTIC ENERGY–MOMENTUM TENSOR OF THE ELECTROMAGNETIC FIELD IN MATTER. de Groot, S. R. (Univ., Amsterdam). pp 96-100 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

The historical development and solution are reviewed for the correct form of the energy–momentum tensor of the electromagnetic field in polarized media, which would fit into the framework of special relativity. (J.F.P.)

23533 RENORMALIZATION OF THE σ-MODEL. Lee, Benjamin W. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France. Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Nucl. Phys., B9: 649-72(1969).

The renormalization of the σ-model in the absence of the baryon fields is considered. The model is characterized by three parameters. In order that the current algebra and the partially conserved axial vector current condition are valid in the renormalized σ-model, it is necessary that all divergences of the theory may be absorbed in two constants, the mass and the coupling constant, and no new ad-hoc parameters be introduced to remove divergences. A perturbation method is presented, in which the lowest order gives rise to the usual results of the current algebra (or chiral dynamics). It is shown that indeed all divergences can be absorbed into the redefinitions of the mass parameter and the one coupling constant. This is achieved by demonstrating the existence of an intermediate renormalization (wherein the counter terms are precisely those of a chiral symmetric theory) which makes the theory finite. As a consequence, the mass difference between the scalar and pseudoscalar particles is finite and all the three point and four point couplings are expressible in terms of one parameter. The vacuum expectation value of the scalar σ field is given by a nonlinear equation. A consistent treatment of this equation is outlined in detail, and the equation is shown to be finite and well-defined after the intermediate renormalization. The possibility of the spontaneous breakdown of the chiral symmetry, through the nonvanishing vacuum expectation value of the σ-field even when the Lagrangian is chiral invariant, is described and the Goldstone theorem is verified up to the second order in perturbation expansion. The treatment of the axial vector current–pion vertex (such as appears in the pion decay), which contains a linear divergence not encountered in the S-matrix expansion, is detailed. The pion decay constant is related to the vacuum expectation value of the renormalized σ field in all orders of perturbation theory. (auth)

23534 AN UNSTABLE PARTICLE IN THE LEE MODEL: EXISTENCE THEOREM. Chan, Vu Duy (Physique Mathematique, Paris). Compt. Rend., Ser. A, B, 268: 357-60(Feb. 10, 1969). (In French).

The existence of an unstable V particle is proven in the case of the absence of a stable particle. It is concluded that when the coupling is weak, the existence of a zero complex of the Hamiltonian in the second Riemann sheet near the cut is certain and represents the unstable V particle in quantum field theory. (J.F.P.)

23535 A CLASS OF FINITE-PART INTEGRATION RULES FOR QUANTUM FIELD THEORY DEFINED BY A METHOD OF ANALYTIC CONTINUATION. Guerra, F.; Marinaro, M. (Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples). Nuovo Cim., 60A: 756-71(Apr. 21, 1969).

A method is presented which permits the regularization of a field theory by means of a procedure of analytic continuation performed on auxiliary parameters. This method differs from those proposed previously essentially because the regularization is performed only on pairs of vertices and not on individual lines of graphs. It is shown furthermore that this regularization is in fact a realization of the finite-part integral, whose introduction was shown in preceding works to be sufficient for obtaining a complete renormalization of field theory. (auth)

23536 WAVE MECHANICS OF FIELDS. Marx, E. (Drexel Inst. of Tech., Philadelphia). Nuovo Cim., 60A: 683-705(Apr. 21, 1969).

A detailed discussion of the Schrödinger approach to wave mechanics applied to free fields instead of particles is presented. The state vector is a functional of the fields and a function of time, and the operators are constructed from the fields as the co-ordinates and functional derivatives with respect to these fields as the momenta, which thus obey the canonical commutation relations. First the complex scalar field along the lines of the harmonic oscillator in ordinary quantum mechanics is studied and it is indicated briefly what changes are introduced when the field is real. Next the massive Lorentz vector field is discussed examining the usual difficulties related to the scalar part, such as negative energies and the indefinite metric. The electromagnetic field is discussed with special attention given to the constraints of the theory. This is done in the usual manner where the potentials are the generalized co-ordinates and in a variation where the fields themselves are the co-ordinates. In both ways a gauge-independent theory is obtained with no redundant variables and no indefinite metric in the space of state vectors. Also the spinor field is discussed briefly, but it is soon realized that this method is not applicable in its present form. New results are not obtained this way, but a new method that brings fresh insights to the problems that beset the quantum theory of fields is explored. (auth)

23537 FORM-INVARIANT RENORMALIZATION. Caianiello, E. R. (Univ., Naples); Marinaro, M.; Guerra, F. Nuovo Cim., 60A: 713-55(Apr. 21, 1969).

This work is intended to accomplish the following purposes: To present a concise and self-contained account of the formal renormalizative techniques developed in the past years; their starting point is the requirement that all equations in x-space defining the Green's functions of a field theory should remain form-invariant under renormalization and be made meaningful by it. To give a definite mathematical content to this method, by exhibiting a specific finite-part integration rule which satisfies all the formal requirements necessary for the method to be applicable (a detailed study of this integration rule is made in the accompanying work by Guerra and Marinaro). To provide the foundations for further investigations on the structure and applications of the renormalization group (of which the first is presented in the accompanying work by F. Esposito, U. Esposito and Guerra). For sake of simplicity, in order to reduce to the bare minimum the necessary combinatorial apparatus, only the standard case of a $g\varphi^4$ coupling is treated; the extension to other theories is straightforward. (auth)

23538 THE RENORMALIZATION GROUP IN A QUANTUM FIELD THEORY REGULARIZED BY FINITE-PART INTEGRATION RULES. Esposito, F. (Univ., Naples); Esposito, U.; Guerra, F. Nuovo Cim., 60A: 772-90(Apr. 21, 1969).

A general analysis is presented which characterizes the structure of the transformation group among regularized field theories, arising from the renormalization method by finite-part integration. (auth)

23539 FIELD THEORY OF CURRENTS. Sakita, B. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 178: 2434-9(Feb. 25, 1969). (COO-881-199).

Realizations of Sugawara's field theory of currents on functionals are discussed from an algebraic viewpoint. It is shown that the realization can also be obtained from a nonlinear Lagrangian of scalar fields. A solvable model of field theory of currents is also investigated in detail. It is shown that the degenerate vacuum is the ground state of the system in this model. (auth)

23540 GAUGE INVARIANCE AND MASS IN SCALAR ELECTRODYNAMICS. Fry, M. P. (Univ. of Toronto). Phys. Rev., 178: 2389-2400(Feb. 25, 1969).

Schwinger has conjectured that zero mass may be suppressed from the physical spectrum of an Abelian, neutral vector gauge field if the current-vector coupling is sufficiently strong. An attempt is made to verify this by direct calculation in scalar electrodynamics. The calculation is based on a self-consistent approach to strong coupling in spinor electrodynamics proposed by Johnson. No evidence is found in support of Schwinger's conjecture within the ladder approximation for the one- and two-photon emission vertices. (auth)

23541 BREAKDOWN OF CURRENT ALGEBRA IN LAGRANGIAN FIELD THEORIES. Hagen, C. R. (Univ. of Rochester, N. Y.). Phys. Rev., 178: 2154-60(Feb. 25, 1969).

It is shown that in a model field theory in one spatial dimension the commutation relations of the usual isospin operators will generally differ from their canonical form provided that the isospin current explicitly appears in the interaction Lagrangian. Although the model is not soluble, it has the important feature of allowing the explicit evaluation of all current commutators without the occurrence of any divergent quantities. Possible generalizations to higher dimensions are briefly discussed. (auth)

Gravitation and General Relativity

Refer also to abstracts 22723 and 23409.

23542 GEOMETRY OF SPINORS. Bown, A. (Wayne State Univ., Detroit). J. Math. Anal. Appl., 25: 537-55(Mar. 1969).

A principal fiber bundle P(M) of spinor frames which has a full linear group as structural group and contains this bundle as a subbundle is introduced. Connections in the setting of P(M) are studied. In addition to the structure equation for a connection on a principal fiber bundle a second structure equation for a connection on P(M) is considered. These two equations furnish necessary and sufficient conditions that a form on P(M) be a connection form. Also the reduction of connections on P(M) is studied, and a theory for spinors is developed. This study contains the theory of metric connections. An application is made in terms of the electromagnetic potential vector in general relativity. (J.F.P.)

23543 EQUIVALENCE OF GENERAL RELATIVISTIC FIELD THEORIES. Knapecz, G. J. Phys., A (London), 2: 207-9 (Mar. 1969).

A theorem of Aczél and Golab (1960) is strengthened and simplified. According to the new theorem any local geometric object $\psi_A(x)$ may be expressed as a differential concomitant of a suitable set of local scalars $S^B(x)$. As a consequence, it is proved that any generally covariant field theory may be described in terms of scalar fields, i.e., that the set of all general covariant field theories is equivalent to its subset of scalar field theories. (auth)

23544 CONSTRUCTION OF RADIATIVE SOLUTIONS APPROXIMATING EINSTEIN EQUATIONS. Choquet-Bruhat, Yvonne. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 44: 649-52(May 1968). (In French).

An approximate radiative solution to the Einstein equations is constructed. Waves approximating zero order and those approximating first order are discussed. Also the energy loss due to gravitational radiation is considered. (J.F.P.)

23545 ON THE STRUCTURE OF THE MAXWELL EQUATIONS. Bleuler, Konrad (Univ., Bonn); Kustaanheimo, Paul E. Ann. Acad. Sci. Fenn., Ser. A VI, No. 298, 1-18(1968).

In view of the great importance of the reflection properties of physical laws it is stressed that the structure of the Maxwellian system is, to some extent, determined from the principle of parity conservation (e.g., invariance with respect to space reflections). These considerations lead in a natural way to the more compact, complex form of the field equations; this new system is written in terms of the combined field $F = E + iB$ which exhibits interesting transformation properties: In fact, the space reflection $x \rightarrow -x$ is now represented by the transition to the complex conjugate field, whereas the transformations of F according to the proper Lorentz group are given by the 3-dimensional irreducible and complex representation of the type (1,0). This transformation law can be replaced, however, by the 2-component Weyl representation $(\frac{1}{2},0)$ if the field F is expressed by a "relativistic motor," i.e., a two-by-two matrix F based on Pauli's matrices $\sigma : F = (\sigma \cdot F)$. This most convenient concept also leads immediately to the even more concentrated matrix-form of the Maxwellian system, i.e., a single matrix equation which exhibits a striking similarity to the Weyl neutrino law. (This form may also be obtained from the spinor equation given previously.) In addition, all characteristic quantities of the theory (potentials and interactions) can be written in terms of the corresponding matrices (i.e., motors) whereby the relativistic invariance of all relations becomes evident. It is emphasized, however, that the conventional tensor-form (and its natural generalization for a manifold) plays a decisive role in the framework of general relativity where a much deeper understanding of the Maxwellian structure is reached. It thus becomes evident that the Maxwellian field is simultaneously related to the realm of cosmological dimensions as well as to the microscopic domain of atoms and nuclei where spinors play a decisive role. (auth)

23546 JUNCTION CONDITIONS FOR SPHERICALLY SYMMETRIC MATTER IN CO-MOVING CO-ORDINATES. Leibovitz, C. (Tel-Aviv Univ., Israel). Nuovo Cim., 60B: 254-60 (Apr. 11, 1969).

The conditions ensuring the possibility of going over to admissible co-ordinates (in the Lichnerowicz sense) are established for the case of co-moving co-ordinates. It is proved that the Oppenheimer-Snyder solution is correctly matched and does not need modifications. Attempted modifications are shown to be incorrect. (auth)

23547 EXACT FIELDS OF CHARGE AND MASS DISTRIBUTIONS IN GENERAL RELATIVITY. Cohen, J. M. (Goddard Space Flight Center, New York); Cohen, M. D. Nuovo Cim., 60B: 241-8(Apr. 11, 1969).

Exact solutions to Einstein's field equations generated via static spherically symmetric mass and charge distributions are presented. In the limit in which the mass density vanishes but the charge density does not, the mass seen by an observer at infinity does not vanish and the metric exterior to the source can be the Ressner-Nordstrom or Schwarzschild solution depending upon the charge distribution. This mass, generated by the energy density of the electromagnetic field, cannot be set equal to zero for a body of finite size. If the charge is concentrated in a thin shell and the charge and mass as seen by an observer at infinity are set equal to those of an electron, the radius of the shell is half the classical electron radius. Finally, we exhibit a class of solutions in which the red-shift (from a point in the body to infinity) is maximum at the surface rather than at the center. (auth)

23548 CONSERVATION LAWS IN GENERAL RELATIVITY. Horsky, J.; Novotny, J. (Purkyne Univ., Brno). Czech J. Phys., 19: 419-42(1969).

A discussion is given of differential and integral conservation laws in field theory covering Noether's theorems, differential conservation laws, and the notation of the integral conservation law. Also classical methods for the solution of the problem are considered including Bianchi identities, superpotential, the Einstein–Klein theorem, and the total momentum and energy radiated out. Finally, unorthodox solutions are presented among which are Rayski's method and Moller's tetrads solution, Rylov' method, Arnowitt's, Deser's, and Misner's solutions, and Bel's and Robinson's tensor. (J.F.P.)

23549 TWO FIELDS OF GRAVITATION AND PROPAGATION OF GRAVITATIONAL WAVES. Carstoiu, John (International Consultant Scientists Corp., Brookline, Mass.). Compt. Rend., Ser. A, B, 268: 201-4(Jan. 20, 1969). (In French).

General gravitation theory is considered. The Einstein equations are not used, and a universe without curvature is conceived. By means of appropriate comparisons the existence of a second gravitational field is shown. The two fields are subjected to a system of equations, which is given. It appears that these two fields are propagated in vacuum with a velocity c. These assumptions replace the Einstein condition. (J.F.P.)

23550 THERMODYNAMICS IN THE SPECIAL AND THE GENERAL THEORY OF RELATIVITY. Moeller, C. (Univ. of Copenhagen. NORDITA, Copenhagen). pp 202-21 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

The discussion of thermodynamics in relativity theory covers a brief review of previous results, relativistic heat engines, and thermodynamics in general relativity theory. (J.F.P.)

23551 THE EXACT SOLUTIONS OF A GRAVITATIONAL WAVE EQUATION FROM EINSTEIN FIELD EQUATIONS. Dangvu, Huyen (Institut Henri Poincare, Paris). Compt. Rend., Ser. A, B, 268: 297-8(Feb. 3, 1969). (In French).

Only gravitational potentials $\psi_{\mu\nu}$ are considered such that $g^{\mu\nu} = g^{\mu\nu} - 2\psi^{\mu\nu}$ ($\psi^{\mu\nu} = g^{\mu\rho}g^{\nu\sigma}\psi_{\rho\sigma}$) $\psi^{\mu}_{\mu} = g^{\mu\nu}\psi_{\mu\nu} = 0$. The example of a central symmetric Finkelstein field is given. (J.F.P.)

23552 NATURAL GAUGE OF A TETRAD FIELD AND GRAVITATIONAL ENERGY. Mitskevich, N. V.; Ribeiro Teodoro, M. (Lumumba Univ. of Friendship of Nations, USSR). Zh. Eksp. Teor. Fiz., 56: 954-62(Mar. 1969). (In Russian).

The tetrad or γ matrix gauge is uniquely found on the basis of the method of observation by means of light rays (isotropic geodesics). The gauge is employed for calculating in Riemannian normal coordinates the gravitational energy density near the observer. This method excludes any paradoxes of the Bauer type. Averaging over the observation angles yields for arbitrary fields a nonnegative value of the gravitational field energy density. The density is zero on the world line of the observer. The case of weak plane gravitational waves is analyzed as an example. A short review of the problem of localizability of gravitational energy is presented. (auth)

23553 UNIFIED DESCRIPTION OF GRAVITATION AND ELECTROMAGNETISM. Arbuzov, B. A. Zh. Eksp. Teor. Fiz., 56: 1046-56(Mar. 1969). (In Russian).

A new unified geometric description of gravitational and electromagnetic fields is proposed. Both fields are described in a fine connection space with nonvanishing curvature and second curvature tensors. A connection expression is obtained which contains along with the gravitational also the electromagnetic field. The effect of the electromagnetic field on the geometry is determined by a new constant with the dimensions of length l_0. Experiment restricts the value of this constant to $l_0 \lesssim 10^{-14}$ cm. Experiments to verify the theory are discussed. The relation between geometrization of the electromagnetic field and violation of T invariance is mentioned. (auth)

Scattering Theory

Refer also to abstracts 23399, 23400, 23509, and 23527.

23554 (UCRL-18769) TWO LECTURES ON S-MATRIX THEORY. Stapp, Henry P. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 19, 1969. Contract W-7405-eng-48. 45p. Dep. CFSTI.

Results obtained during the past few years on the analytic structure of many-particle amplitudes in the physical region are summarized. The results are derived mainly from the cluster decomposition and macrocausality requirements. The macrocausality requirement is described. (auth)

23555 NEGATIVE METRIC AND THE UNITARITY OF THE S-MATRIX. Lee, T. D. (CERN, Geneva); Wick, G. C. Nucl. Phys., B9: 209-43(1969).

It is shown that the introduction of a negative metric in quantum mechanics can lead to a unitary S-matrix, provided that all stable particle states are of positive square length. Such a possibility can be used to remove divergence difficulties in physics, while maintaining unitarity and relativistic invariance. For example, to the zeroth order of e^2, the usual photon propagator may be replaced by $(q^2)^{-1} - (q^2 + m^2)^{-1}$, and to the zeroth order of the weak interaction constant G, the intermediate boson $W^{\pm}$ propagator may be given simply by $\delta_{\mu\nu}(q^2 + m^2)^{-1}$, assuming that m is not too small. The general theoretical implications of such a theory with negative metric, but unitary S-matrix, are analyzed. Its various experimental consequences are discussed. Explicit examples are given for some soluble models. (auth)

23556 ANALYTIC BEHAVIOR OR THE SCATTERING AMPLITUDE IN THE DIRAC THEORY. Barthelemy, Marie-Claire (CNRS, Paris). Compt. Rend., Ser. A, B, 268: 585-8(Feb. 24, 1969). (In French).

Returning to previous notation, the analyticity in the complex x plane of a radial Dirac system conformable to the original is studied. Also studied are a localization of poles of $e^{2i\eta_x(k)}$ and a summation formula of the Watson type in the complex plane. (tr-auth)

23557 ASYMPTOTIC CONTRIBUTIONS OF REGGE CUTS TO FORWARD AMPLITUDES. I. THEORY. Yndurain, F. J. (CERN, Geneva). Nuovo Cim., 60A: 405-28(Apr. 1, 1969).

The contributions to high-energy forward elastic-scattering amplitudes of possible cuts in the complex angular-momentum plane (Regge cuts) are considered. After a survey of the necessity of their incorporation, a very general conjecture is made about their structure (viz., positivity of the jumps). It is then shown that this assumption is sufficient to prove that the absorptive parts of the corresponding scattering amplitudes are nonoscillating at high energy. Hence finite-energy sum rules and dispersion relations can be computed. The asymptotic behaviors of these are then analyzed both when the leading l-plane singularities contain cuts, and when they do not. It turns out that these two possibilities lead to drastically different predictions, which are then used to propose experimental tests of the existence of Regge cuts, showing that such tests are feasible with the help of presently available data; their relevance is discussed. Some of the results of these tests, are given. A completed and improved survey of them will be presented separately. (auth)

23558 COMPOSITENESS CONDITIONS FOR PARTICLE POLES IN PARTIAL WAVE SCATTERING AMPLITUDES. I. Kaschluhn, F. (Humboldt-Univ., Berlin. Institut fuer Hochenergiephysik, Berlin). Fortschr. Phys., 16: 669-85(1968).

Compositeness conditions for particle poles in partial wave scattering amplitudes are studied with particular regard to various dynamical limits connected with a continuous transition from elementary to composite particles. Some simple, but nontrivial models are considered; and the present considerations are generalized; and also the question of analytic continuation in the angular momentum and the many-channel case is treated. (auth)

23559 MASS FORMULA FOR REGGE DAUGHTERS. Taylor, J. C. (Oxford Univ.). Nucl. Phys., B9: 201-8(1969).

It is shown that singularities at $t = 0$ in the Regge amplitude for unequal mass, spinless particle scattering can be cancelled by a single series of daughters, provided that the kth daughter trajectory $\alpha_k(t)$ is given implicitly as a function of k and t by an expansion of a certain form (mass formula). The mass formula differs from those previously found in being implicit and in going to a general power of t. Expressions for the residues are also found. Parity doublet trajectories (with Toller quantum number $M \neq 0$) are not treated. (auth)

23560 AN ALGEBRAIC METHOD FOR UNITARIZING EXCHANGE DIAGRAMS AND DETERMINING SCATTERING AMPLITUDES. Wiegand, G.; Blomer, R. (Univ. of Munich). Nucl. Phys. B9: 106-12(1969).

An algebraic method for unitarizing exchange diagrams and calculating scattering amplitudes in a cutoff-free way is proposed. The approach is based on the topological properties of the Riemann energy surface of partial wave amplitudes. As an example an N/D solution is determined algebraically. (auth)

23561 HIGH-ENERGY CROSS SECTIONS, DIFFRACTION SLOPES AND PHASE OF THE FORWARD SCATTERING AMPLITUDE. Mickens, R. E. (Massachusetts Inst. of Tech., Cambridge). Nuovo Cim., Lett., 1: 521-6(Apr. 11, 1969).

A crossing symmetric representation for high-energy scattering amplitudes is formulated in Regge pole theory, from which bounds on the high-energy cross sections, diffraction slopes, and the phase of forward scattering amplitudes are obtained. (L.B.S.)

23562 ANALYTICAL CONTINUATION IN THE DETERMINANTAL METHOD. Benayoun, M.; Leruste, P. (Laboratoire de Physique Atomique et Moleculaire, Paris). Nuovo Cim., Lett., 1: 548-51(Apr. 11, 1969).

A new formulation is given of Newton's substitution rule whereby the Fredholm determinant of the Lippmann-Schwinger equation is expressed in terms of determinants constructed on the multichannel reduced-reactance K-matrix. The formulation is equivalent, in every case of discrete thresholds, to the analytic continuation procedure. (L.B.S.)

23563 ASPECTS OF THE RESONANCE-PARTICLE-POLE RELATIONSHIP WHICH MAY BE USEFUL IN THE PLANNING AND ANALYSIS OF EXPERIMENTS. Chew, G. F. (Univ. of California, Berkeley). pp 80-95 of Old and New Problems in Elementary Particles. Puppi, G. (ed.). New York, Academic Press Inc., 1968.

A review of S-matrix theory is given. Emphasis is placed on the uniqueness of pole position (in the Riemann surface determined by threshold branch points) independent of the particular reaction considered. This position is thus the natural and unambiguous generalization of the particle–mass concept. The factorizability of all pole residues and the dynamical equivalence of a variety of different regions on the unphysical sheets of the Riemann surface are considered. Also emphasized is the possibility of unique extrapolation from the physical region in order to determine pole positions and residues. (J.F.P.)

23564 THEORETICAL ASPECTS OF HIGH ENERGY PHENOMENOLOGY. Bertocchi, L. (CERN, Geneva). 160pp 160-232 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.

See CONF-671079.

A review is given of some of the theoretic aspects of high-energy phenomenology including Reggeization of helicity amplitudes, the problem of dips and ghost-killing mechanisms in Regge theory, and crossover phenomena. (L.B.S.)

23565 PROBABILISTIC INTERPRETATION OF RELATIVISTIC SCATTERING. Marx, E. (Drexel Inst. of Tech., Philadelphia). Nuovo Cim., 60A: 669-82(Apr. 21, 1969).

A detailed discussion of the interpretation of a scattering process within the framework of relativistic quantum mechanics is presented. This argument is particularly well suited to the scattering of charged scalar particles in an external electromagnetic field, but it breaks down for spin-$\frac{1}{2}$ particles. In the latter case, one can improve certain features if the Klein–Gordon equation is used instead of the Dirac equation. (auth)

23566 S-MATRIX THEORY OF CURRENTS. I. Omnes, R. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Rev., 178: 2245-53(Feb. 25, 1969).

The problem of the determination of currents and the off-mass-shell extension of scattering amplitudes is considered within the context of analytic S-matrix theory, keeping up to three particles inside the unitary relations. The technique used is a straightforward application of the work by Mandelstam on the N/D formulation of the three-body problem. It is found that anomalous thresholds do not play any role in the problem and that two cases can be solved explicitly, namely, the extension off the mass shell of a scattering amplitude and the computation of a form factor which tends to zero asymptotically. (auth)

23567 ASYMPTOTIC FORM OF THE WAVE FUNCTION FOR THREE-PARTICLE SCATTERING. Nuttall, J.; Webb, J. G. (Texas A and M Univ., College Station). Phys. Rev., 178: 2226-9 (Feb. 25, 1969).

The asymptotic form of the wave function for scattering from an initial state of one-particle incident on a bound pair at energies above the breakup threshold is given. Unknown corrections are rigorously square integrable. The discussion is valid only for short-range forces. (auth)

23568 RELATION BETWEEN THE EIKONAL AND MANDELSTAM REPRESENTATIONS. Narayan, D. S.; Rangwala, A. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 178: 2323-8(Feb. 25, 1969).

The even and odd parts $A^{\pm}(s,t)$ of a scattering amplitude having Mandelstam singularity structure are explicit functions of the transverse momentum $P_t = k \sin\theta$. It is shown that $A^{+}(s,t)$ and $A^{-}(s,t)/\cos\theta$ can always be put in an eikonal (impact parameter) representation which is valid at all energies and angles, such that the new representation for the full amplitude $A(s,t)$ agrees with the usual eikonal approximation in the limit of small angles and high energies. A relation between the asymptotic growth of the t- and u-channel absorptive parts and the nature of the singularity of the eikonal function $\chi(b,s)$ for zero impact parameter is also established. Moreover, if the function $e^{i\chi(b,s)} \sim 1/b^{\alpha(s)+2}$ with $\alpha(s) > -2$, a family of moving Regge poles in the complex l plane at $l = \alpha(s) - 2n$ ($n = 0, 1, \ldots$) will result giving a connection between the positions of a family of the Regge poles in the complex l plane and the nature of the singularity of the eikonal function for zero impact parameter. (auth)

23569 REGGE-POLE FAMILIES AND TOLLER POLES: $t = 0$. Di Vecchia, P. (CNEN, Frascati, Italy); Drago, F. Contracts F61052 67 C 0084; AT(11-1)-68. Phys. Rev., 178: 2329-42 (Feb. 25, 1969).

It is explicitly shown, using the factorization theorem, that the $M = 0$ and $M = 1$ Regge-pole families, deduced from analyticity in unequal-mass scattering processes, are the same as the families generated, in the equal-mass situations, from $M = 0$ and $M = 1$ Toller poles. (auth)

23570 COMPOSITE PARTICLES IN S-MATRIX THEORY AND IN FIELD THEORY. Cornwall, John M. (Univ. of California, Los Angeles. Univ. of Copenhagen); Levy, Donald J. Phys. Rev., 178: 2356-64(Feb. 25, 1969).

A model-independent exact solution is given in S-matrix terms to the problem of relating proper vertex functions and physical scattering amplitudes, a problem studied extensively by Ida. The solution is of the Omnès type, supplemented by the solution of some algebraic equations. Conventional definitions of the renormalization constants Z_1 and Z_2 are used to study the composite limit ($Z_1 = Z_2 = 0$) in S-matrix theory. A model-independent discussion of the same problem is given in terms of the Dyson equations, where essentially the same results are recovered, in a different language. Possible applications to the electromagnetic mass shifts of composite particles are briefly discussed, including problems of gauge invariance. (auth)

23571 CROSSING-SYMMETRIC REGGE AMPLITUDE, COMPLEX TRAJECTORY FUNCTIONS, AND PHASE CONTOURS. Kaiser, G. D. (Univ. of Miami, Coral Gables, Fla.). Phys. Rev., 178: 2372-6(Feb. 25, 1969).

The behavior of a crossing-symmetric Regge model is discussed in the complex t plane at fixed s. The trajectory function is allowed to take on an arbitrary imaginary part. Phase contour maps are drawn. (auth)

23572 CROSSING EQUATIONS AND KINEMATIC CONSTRAINTS IN ELASTIC SCATTERING. Actor, Al (Univ. of California, Los Angeles). Phys. Rev., 178: 2401-20(Feb. 25, 1969).

The Trueman–Wick equations which connect any elastic-scattering channel with its crossed channel are, by assuming parity and time-reversal invariance in the elastic channel, decomposed into four much smaller closed systems of equations. To achieve this, new amplitudes are introduced which are certain linear combinations of helicity amplitudes. The new equations are put in a very simple factorized matrix form, and a list is given of all matrices encountered when neither spin is larger than $^3/_2$. In terms of the new amplitudes, elastic-channel forward scattering constraints are of two distinct types. These are given expression for arbitrary spins. In the Regge model, one type requires conspiracy or evasion. The other type requires neither. Kinematic singularities and constraints at threshold (pseudothreshold) are discussed in terms of the new formalism. (auth)

23573 WKB METHOD FOR THREE-DIMENSIONAL PROBLEMS. Khudyakov, S. V. Zh. Eksp. Teor. Fiz., 56: 938-49 (Mar. 1969). (In Russian).

The quasiclassical expression for the wave function in a three-dimensional analytic potential is investigated near caustics where the approximation breaks down. A function is set up which approximates the exact solution of the Schroedinger equation in a finite region of space including the caustics. The scattering amplitude is determined in the region of the caustic in which the quasiclassical cross section diverges. (auth)

Particle Accelerators

Refer also to abstracts 22048, 22102, 23227, and 23728.

23574 (AD–675120) SOVIET PARTICLE ACCELERATORS: ANALYTICAL REVIEW. Surveys of Foreign Scientific and Technical Literature. Polushkin, A. (Library of Congress, Washington, D. C. Aerospace Technology Div.). Oct. 4, 1968. 298p. (ATD–67–56). CFSTI.

The report reviews Soviet work on particle accelerators that includes research, development, construction and operation of the devices and associated equipment. The material is based exclusively on Soviet open-source publications dated from 1962 through 1967. The treatment employed is keyed to the Soviet organizations, mainly research institutes, that carry on the particle accelerator work, and to the various specialized teams or groups that can be identified within each such organization. Particular attention is paid to associate the personnel with specific subjects, functions and the leadership structure. The report ends with a number of appendices that provide a statistical summary of the entire material. This includes a ready reference list of all the Soviet accelerators described or tabulated in the text, and several tables presenting a three-dimensional distribution of the source documents used in the report: by subject, time, and facility. The tables thus reflect annual changes in publication activity of each organization within the principal areas of interest. The report is also provided with an alphabetic index of all personnel, indicating their affiliation. (auth)(USGRDR)

23575 (ANL-Trans–721) ELECTRON BEAM MULTICHARGED ION SOURCE. Donets, E. D.; Ilyushchenko, V. I.; Alpert, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report JINR–P7-4124. 21p. Dep. CFSTI.

An ultrahigh-vacuum electron beam source of highly stripped ions was constructed for investigation of the ionization processes of positive ions by electronic impact and for production of the multicharged ion beams. Ionization is carried out by means of an intense magnetofocused electron beam. The results of preliminary experiments on ionization of residual gas atoms are presented. (auth)

23576 (BARC-372) FIVE PORT BEAM SWITCHING MAGNET FOR USE WITH 5.5-MeV VAN DE GRAAFF ACCELERATOR. David, T. P.; Sarma, N.; Rao, P. R. Sunder; Bhatia, M. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 27p. Dep.

The design of the magnet, including pole pieces, magnet coils, cooling system, power supply, magnet mount, and stabilization and control circuits, for switching the beam from a 5.5-MeV Van de Graaff accelerator to any one of five target chamber beam ports is presented. (W.H.K.)

23577 (CERN-Trans–68-12) COHERENT TRANSVERSE BEAM OSCILLATIONS IN ACCELERATORS WITH SELF-REGULATION. Zhil'kov, E. A. Translated into French by E. Osteletsky (CERN, Geneva), from At. Energ. (USSR), 22: 497-8(1967). 4p. (In French). Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 44481. (W.H.K.)

23578 (CERN-Trans–68-19) PARAMETRIC RESONANCE CROSSING IN ACCELERATORS WITH INTENSE BEAMS. Balbekov, V. I.; Shukeilo, I. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated into French by A. Golovanoff (CERN, Geneva), from report IFVE-SKU–67–35–K. 25p. (In French). Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 44535. (W.H.K.)

23579 (JINR–P16–4304) BUILDUP OF THE LOW-ENERGY RADIATION IN THE ACCELERATOR SHIELDING. Sychev, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1969. 36p. (In Russian). Dep.

Analytical expressions for the spatial distributions of the neutron energy spectra ($E < 20$ MeV) and the γ-radiation dosage in the proton accelerator shielding are presented. (auth)

23580 (ORNL–TM–2498) CALCULATION OF THE RESIDUAL PHOTON DOSE RATE AROUND HIGH-ENERGY PROTON ACCELERATORS. Armstrong, T. W.; Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Feb. 10, 1969. 41p. Dep. CFSTI.

Calculations were carried out to determine the time dependence of the residual photon dose rate around a high-energy proton accelerator. The development of the nucleon–meson cascade, the residual nuclei production, and the photon transport are calculated, using Monte Carlo methods. Proton beams of 3 and 200 GeV and shields in the form of infinite cylinders of iron and heavy concrete are considered. Although the 3-GeV calculations are carried out with some exactitude, the results for the 200-GeV case must be considered very approximate since the energy and angular distributions of the products from nuclear interactions in this energy range are not well known. (auth)

23581 SENSITIVE PHOSPHOR FOR DISPLAY OF PARTICLE BEAMS. Ettinger, K. V.; Stewart, F. R. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods, 69: 350(Apr. 1969).

A new phosphor based on europium activated yttrium orthovanadate (YVO_4) was investigated in connection with preparation of screens for visual display of charged particle beams. The new phosphor, which is available commercially exhibits high sensitivity and good durability, when used on cyclotron beams. (auth)

23582 CALORIMETER AS A PRIMARY STANDARD BEAM MONITOR. Loe, R.; Loh, E. (Cornell Univ., Ithaca, N. Y.). Nucl. Instrum. Methods, 69: 323-4(Apr. 1969).

A mercury filled calorimeter was designed and constructed at Cornell to serve as a primary standard for measuring total energy in electron and bremsstrahlung gamma beams. The accuracy of this device is about $\frac{1}{2}$% at a heat input of 4 W. The calibration constant for a Wilson type quantameter was obtained using the calorimeter. (auth)

23583 PULSE GENERATOR FOR A MEGAVOLT TOTAL CHARGING VOLTAGE IN A COMPACT VOLUME. II. THE DISCHARGE TUBE. Nicolai, E.; Lange, F. (Institut fuer Biophysik, Berlin). Nucl. Instrum. Methods, 69: 213-24(Apr. 1969). (In German).

The building of a fit discharge tube and the research made with this apparatus are described. The discharge tube is a laminated tube by Lange, with a length of 30 cm for 1 MV. It is embedded in isolating oil. The beam hardness was determined by deflection of the electrons in a magnetic field. The quantity of the charges was measured by means of a Faraday cage and the energy of the electron beam pulses by a calorimeter. The dose rate (dose/pulse) of the microsecond pulses is in accordance, directly under the exit window with a diameter of 2 cm, from about 10 krad to some Mrad. The pulsed electron beam source is used for research in radiobiology. (auth)

23584 TIME-OF-FLIGHT SYSTEM FOR USE WITH THE SLAC 1.6 GeV/c SPECTROMETER FACILITY. Anderson, R. L.; Porat, D. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 70: 77-86(Apr. 1, 1969).

A time-of-flight system has been built for particle identification with the SLAC 1.6 GeV/c spectrometer facility. The system makes use of a nanosecond modulation of the SLAC primary electron beam. The flight time of the particle is determined by comparing the phase of the arrival of a pulse from a counter at the counting electronics to an rf waveform extracted from the deflection plates which modulate the accelerated beam. The system is relatively simple and has been used successfully in several experiments at SLAC. (auth)

23585 SOURCES OF POLARIZED NEGATIVE HYDROGEN OR DEUTERIUM IONS BASED ON THE $2S_{1/2}$ STATE PROPERTIES. Cesati, A.; Christofori, F.; Colli, L. M.; Sona, P. G. (CISE, Milan. Univ., Milan). Progr. Nucl. Phys., 10: 117-65(1969).

The studies described are concerned with the problem of obtaining a beam of highly polarized particles for injection into particle accelerators, particularly in regard to the requirements of high intensity, technical simplicity, etc. A method is described which gives the hope of meeting these essential requirements, making use of the properties of the H-atom excited in the $2S_{1/2}$ metastable state to produce polarized protons or deuterons. A beam consisting of about 10^{10} negative deuterium ions per sec, with a polarization value of the P_{33} tensor component in agreement with the theoretical value of -0.26 may be obtained. The theoretical and experimental aspects of this method are described. The theory of the behavior of a H-atom in the $2S_{1/2}$ metastable state in magnetic and electrostatic fields is first given. The problem of producing a beam of H-atoms in this state, and measurement of its intensity, is then considered, followed by a consideration of metastable atom ionization to H^-, which is a convenient way of ionization. The method of measuring the polarization obtained is then described, together with experimental results. Finally, conclusions are drawn regarding advantages of the method and its possible developments. A bibliography of 38 references is included. (UK)

23586 SLAC HIGH POWER HYDROGEN TARGET. Anderson, R. L. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 70: 87-9(Apr. 1, 1969).

A hydrogen target designed for use with the SLAC high power electron and photon beams is described. The target makes use of rapid convection currents caused by the heating of the hydrogen by the beam and the immediate cooling of the warmed hydrogen by a heat exchanger positioned a few centimeter above the beam. Provided that the size of the beam spot is not too small, the convection currents set up, cause the hydrogen to move sufficiently rapidly to prevent the hydrogen (held several degrees below its boiling point by the heat exchanger) from boiling. (auth)

23587 SECTIONING THE ACCELERATING SYSTEM OF A WAVEGUIDE SYNCHROTRON. Gos'kov, P. I. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 9, 139-42(1968). (In Russian).

It is desirable to convert circular, closed waveguide systems to straight sections in order to carry out physical experiments, and also for introducing, removing and controlling the beam. The reflecting properties of a resonance filter are employed to accomplish this task in the most efficient manner. It is important that the interaction space in the filter be as great as the interaction space in the accelerating system. A dowel structure with different heights of the dowels is employed for the separate electrodynamically-insulated end structures having a high shunt resistance. A significant part of the electromagnetic waves are reflected because of the impedance jump at the boundary of the two different waveguide structures. The waves penetrating into the filter structure are rapidly dampened, since the working frequency of the accelerating structure is in the nontransmission band of the filter structure. Experimental study showed that the shunt resistance was 21 kohm/cm in the presence of a resonance filter, and was about 5 kohm/cm in the presence of metallic end shortening pieces with large holes in the center for the passage of the electrons. Thus it becomes possible to construct accelerating sections of waveguide synchrotrons with high shunt resistance for any interaction space, and consequently, to decrease the requirements for high-frequency power. (TTT)

23588 TANDEM PULSE EQUIPMENT (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1856). 70 drawings.

Subnanosecond pulsing equipment is described for the tandem Van de Graaff accelerator. The equipment extends nuclear research studies into energy ranges available from the machine for (p,n) and (d,n) reactions, inelastic scattering of protons, fast neutron cross sections, and charged particle identification. The equipment is added as a second ion source in parallel with the original ion source. Performance is such that at the target the burst duration of the pulses is a minimum of 0.6 nsec. Peak current in the pulse is 450 μA for H^+. Repetition rate is 2.5×10^4 pulses/sec, which gives an average current of 0.6 μA. (For details see TID-4100, Suppl. 52.) (F.S.)

23589 POLARIMETER FOR POLARIZED PROTON AND DEUTERON BEAMS. Kilian, K.; Fick, D. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods, 69: 261-7(Apr. 1969). (In German).

In experiments with polarized beams it is necessary to measure beam current I and beam polarization P fairly continuous and independent of the real experiment. Therefore a Faraday cup must be combined with a polarimeter. Contrary to common scattering experiments the polarimeter has to work with beams of large diameter. In order not to restrict the range of operation the scattering angles Θ of the polarimeter have to be variable. A construction is described which realizes these conditions. First results are shown using the polarimeter reaction $^7Li(p,\alpha)^4He$. (auth)

23590 LABORATORY 50 kV ELECTRON GUN. Jakubowski, Lech; Skladnik-Sadowska, Elzbieta (Inst. for Nuclear Research, Swierk, Poland). Przegl. Elektron., 10: 9-18(1969). (In Polish).

A detailed description of the construction of a laboratory electron gun which ensures a beam current up to 15 mA and 50 kV of extraction voltage is presented. The most advantageous parameters and operational characteristics of the gun are established. By means of static and dynamic methods the shape and convergence of the electron beam as well as current density distributions over the beam cross-section were investigated. Thus the minimum beam diameter at 100 μA current was equal 0.1 mm. For greater currents (several mamps at 15 kV) the average current density achieved 25 mA/mm² at 0.5 mA beam diameter. (auth)

23591 TEMPERATURE CONTROL OF METALLIC TARGETS IN VACUO BY ELECTRON BEAM AND INFRARED RADIOMETRY TECHNIQUES. Lewis, Robert N.; Van Loon, L. S.; Holt, Ben D. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 40: 698-702 (May 1969).

A system is described that employs infrared radiometry and electron beam techniques to raise sequentially the temperatures of small metal targets from a level near liquid nitrogen to the 100 to 600°C range. The system is automatic and achieves the selected temperature with an over-all error less than 0.5°C. (auth)

23592 THIN LITHIUM TARGETS SEALED IN NICKEL FOR LOW OXYGEN CONTAMINATION. Weisser, David C.; Hobbie, Russell K. (Univ. of Minnesota, Minneapolis). Rev. Sci. Instrum., 40: 683-5(May 1969). (COO-1265-75).

A technique is described for making pure lithium targets in the range of 100 μg/cm² by encapsulation in a sputtered nickel film. The oxygen impurity is about 2%. (auth)

23593 EXPERIMENTAL PROGRAMS FOR ADONE. Amaldi, U. Jr. (Istituto Superiore di Sanita, Rome). pp 142-59 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.

See CONF-671079.

Seven experiments which are in preparation for Adone are briefly discussed from the point of view of the expected results. These include a search for 1^- boson; $\pi^+\pi^-$ and $K\bar{K}$ production; the detection of $p\bar{p}$ pairs, $\phi \to K\bar{K}$ and $\phi \to \mu^+\mu$ decays; $\mu^+\mu^-$ and $\gamma\gamma$ experiment for testing the validity of quantum electrodynamics; and a search for leptonic quarks and heavy leptons. Second generation experiments which will involve the use of magnetic fields to measure the momenta of the charged particles produced in the interaction region are briefly summarized. (L.B.S.)

23594 RECENT PROGRESS ON POLARISED PROTON TARGETS. Borghini, M. (CERN, Geneva). pp 33-41 of Proceedings of High Energy Physics Meeting, Pisa, Italy, October 9, 10, 11, 1967. Scribano, A. (ed.). Pisa, Italy, Istituto Nazionale di Fisica Nucleare. Istituto di Fisica, 1967.

See CONF-671079.

Two new types of polarized proton targets are briefly discussed: a longitudinal coplanar target and an alcohol target. Some parameters defining the ethanol target and the LMN:Nd target are compared. (L.B.S.)

23595 NEGATIVE PARTICLE PRODUCTION AT THE 70 GeV IHEP ACCELERATOR. Bushnin, Yu. B. (Inst. for High-Energy Physics, Serpukhov, USSR); Denisov, S. P.; Donskov, S. V.; (and others). Phys. Lett., 29B: 48-53(Mar. 31, 1969).

Data are presented on the yields of π^-, K^-, and $\bar{p}$ produced at small angles by 70 GeV proton-aluminum interactions. The momenta of the secondaries studied were greater than 40 GeV/c. Upper limits have been obtained on the production of antideuterons and possible new particles up to a mass of 2.2 GeV in this new energy region. (auth)

23596 EVA, THE 85-MeV LINEAR ELECTRON ACCELERATOR AT AMSTERDAM. Bruinsma, P. J. T.; de Vries, C. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Ned. Tijdschr. Natuurk., 34: 338-43(Nov. 1968). (In Dutch).

The characteristics of the Amsterdam 85-MeV linear electron accelerator EVA are summarized. Typical results obtained with the elastic scattering of electrons on carbon and proton using hydrocarbon targets and with the inelastic scattering of electrons on ^{51}V are shown to illustrate the use of the machine. (J.S.R.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 23228, 23671, and 23995.

23597 (AE-348) COMPUTER PROGRAM FOR INELASTIC NEUTRON SCATTERING BY AN ANHARMONIC CRYSTAL. Bohlin, L.; Ebbsjoe, I.; Hoegberg, T. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Feb. 1969. 51p. Dep.

A description is given of the program SAW (shift and width), which calculates the energy-dependent shift and width of the intensity peaks obtained for thermal neutrons scattered inelastically by an anharmonic crystal. The program was written in FORTRAN IV and may be applied to every solid with a monoatomic face-centered cubic lattice where the intermolecular interactions can be described by a centro symmetrical potential. Interactions beyond third neighbors are neglected. (auth) (Sweden)

23598 (AEEW-R-621) RECOMMENDED FORMULAE AND FORMATS FOR A RESONANCE PARAMETER LIBRARY. James, M. F. (Atomic Energy Establishment, Winfrith (England)). Aug. 1968. 42p. Dep. CFSTI. UK 6s. 0d.

A proposed library of neutron resonance parameters to be set up on punched cards and magnetic tape is described. This will complement the cross-section data in the present UK Nuclear Data Library. Parametric formulas for the resolved resonance region are given, based on the Breit-Wigner approximation, other approximations of R-matrix theory, and the formulas of Adler and Adler. In addition, the statistical distributions of the parameters are given. The recommended formats for the parameters of the various formulas are also given. (auth) (UK)

23599 (AI-AEC-12757) SCORE II: AN INTERACTIVE NEUTRON EVALUATION SYSTEM. Dunford, C. L.; Berland, R. F.; Hubner, R. S.; Creasy, R. J. (Atomics International, Canoga Park, Calif.). Mar. 1, 1969. Contract AT(04-3)-701. 106p. (ENDF-126; IBM-320-3241). Dep. CFSTI.

The ability to analyze and evaluate the increasing amount of new neutron cross-section information is a vital part of the effort to design economic nuclear reactors. By application of computer graphics techniques, one may supply the cross-section evaluator with the tools which are necessary. By permitting man-computer interaction through computer graphics, both the rapidity and equality of evaluations will be greatly increased. A brief description of a prototype system, SCORE, is described in this document. Methods tested during the development of this prototype evaluation system have widespread general applications as well. (auth)

23600 (BLG-431) A TABULATION OF THE DOPPLER INTEGRAL. De Corte, L. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Nov. 1968. 25p. Dep.

The Doppler integral $\psi(x,\tau) = 1/(2\sqrt{\pi\tau}) \int_{-\infty}^{\infty} \exp[-(x-y)^2/4\tau]/1 + y^2\, dy$ has been calculated for nonnegative values of the arguments x and τ. The differential equation satisfied by $\psi(x,\tau)$ was integrated numerically. An approximation formula was also used in the computation, the accuracy of which was checked by Gauss integration. Tables are included to seven decimal places. (auth)

23601 (CEA-R-3613) EXPERIMENTAL STUDY OF THERMAL NEUTRON SPECTRA IN GRAPHITE UP TO 2200^0K. Ageron, Paul; Briand, Alain; Mouraille, Herve; Warlop, Raymond (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Oct. 1968. 27p. (In French). Dep.

Hot neutron beams (0.12 to 0.5 eV) obtained by high-frequency heating of a graphite moderator introduced into the reflector of the SILOETTE reactor were investigated. Time-of-flight measurements showed that between 0.2 and 0.5 eV a notable increase of the neutron flux was obtained as the temperature of the moderator was increased up to 2200°K. (D.C.W.)

23602 (EUR-4216) INELASTIC SCATTERING OF NEUTRONS BY LOCALIZED VIBRATIONS OF INTERSTITIAL HYDROGEN IN METAL LATTICES: CASE OF A VANADIUM LATTICE. Blaesser, G.; Peretti, J.; Toth, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1969. 41p. Dep.

The contribution of the localized vibrations of hydrogen atoms in a vanadium lattice to the inelastic neutron scattering is calculated on the basis of Fine's model for the interaction within the lattice. A new method is used for the determination of the frequencies of the localized modes which avoids the solution of a secular determinant. (auth)

23603 (GA-9194) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending December 31, 1968. Slaggie, E. L.; Borgonovi, G. M.; Sprevak, D.; Houston, D. H. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 15, 1969. Contract AT(04-3)-167. 26p. Dep. CFSTI.

Neutron scattering by beryllium was studied theoretically. A description of the experimental studies performed on a beryllium single crystal at the end of the preceding contract year is given. Also a code was written to calculate the single differential one-phonon scattering on the basis of a theoretical model; preliminary experimental and theoretical results are reported. Broadening of the theoretical results to account for finite angular resolution in the experiment remains to be done before the data and the calculation can be compared. In addition to single differential studies, work has continued on the calculation of double differential coherent inelastic scattering by beryllium. The main goal is to develop a code that is fast enough to permit the practical calculation of a coherent one-phonon scattering law. The testing of a relatively speedy interpolation method by comparing its results with those of an exact calculation is reported. A measurement of the total cross section of zirconium hydride is reported. The data are in satisfactory agreement with the predictions of a central force lattice dynamical model developed previously. An adaptation of this model to the calculation of phonon frequency distributions for uranium carbide is discussed. Other theoretical work reported here includes progress in the writing of a code to compute coherent elastic scattering from a cubic lattice and further steps in the theoretical formulation describing the temperature dependence of the phonon frequency distribution for nonprimitive lattices. Steps in the derivation of a relation between normal mode frequencies and lattice distortions are given. (auth)

23604 (IN-1280) MACS C: A COMPUTING PROGRAM FOR CRYSTAL VIBRATIONS WHICH INCLUDES LONG-RANGE COULOMB INTERACTIONS. Boyter, J. K.; McMurry, H. L.; Solbrig, A. W. Jr.; Martin, Richard M. (Idaho Nuclear Corp., Idaho Falls). Mar. 1969. Contract AT(10-1)-1230. 80p. Dep. CFSTI.

The program described here is one of a collection of computer programs aimed at giving maximum capability for calculating the slow-neutron scattering by moderators. The program calculates crystal vibrations when the potential energy is a sum of parts arising from short-range forces and long-range Coulomb interactions. It also calculates and punches Jacobian matrices for use in determining adjustments in force constants and ionic charge which can lead to improved agreement with data. Finally, structure factors for neutron inelastic scattering can be calculated. The program is a modification of earlier programs which can not easily include the contribution of Coulomb interactions, and are limited to calculating Jacobian matrices for only valence force potential functions. (auth)

23605 (INR-966) SEMIINFINITE ALBEDO PROBLEM. Bednarz, R.; Kuszell, A. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 30p. Dep.

The solution to the albedo problem with the boundary condition that is dependent on the angle of incidence and the position on the irradiated plane was found. Kaper's technique of the solution of one-velocity three-dimensional isotropic scattering Boltzmann equation was used. As an illustration the problem of periodic irradiation is considered. (auth)

23606 (JINR-P4-4202) WAVE DIFFRACTION IN THE PRESENCE OF SOME REFRACTION INDICES. Baryshevskii, V. G.; Korennaya, L. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 9p. (In Russian). Dep.

Neutron and γ-quantum diffraction in a medium having some refraction indices is considered. It is shown that the account of the change in the radiation wavelength leads to the possible appearance of polarization in the initial nonpolarized neutron beam as a consequence of the pure magnetic diffraction reflection. The influence of the diffraction effects on the electron and cyclotron resonances in the crystals with the polarized nuclei is pointed out. (auth)

23607 (RCN-94) MICROFLUX-2: A PROGRAM FOR THE CALCULATION OF THERMAL GROUP CONSTANTS BY SOLVING THE ENERGY AND SPACE DEPENDENT INTEGRAL TRANSPORT EQUATION FOR SLABS, CYLINDRICAL CELLS, AND FOR HEXAGONAL AND SQUARE LATTICES. Tas, A.; van Ligten, D.; den Houting, A. W. (Reactor Centrum Nederland, Petten). Oct. 1968. 176p.

The ALGOL program MICROFLUX-2, based on the space- and energy-dependent integral neutron transport equation calculates thermal group constants in slabs, cylindrical Wigner Seitz cells, and in hexagonal and square lattices with maximum two different sorts of rods. Maximum cut-off is 2.5 eV. Condensation in more than one thermal group is possible. Options are made to apply the Doppler correction to cross sections near resonance lines, to calculate self-shielding factors in grains of burnable poison of any composition in any material, and to introduce so called external elements for the calculation of activation ratios. The user can choose from the scattering models of Brown and St. John, Koppel Young (KY) and others. For anisotropic scattering corrections can be by adapting the diagonal elements of the scattering matrices. Microscopic cross sections and KY matrices are compiled in the library THERMALIBR. The program is in operation on a 48 K PHILIPS ELECTROLOGICA X8 computer. A review of the theory, a short description of the ALGOL program and THERMALIBR, and a user's manual are presented together with a sample problem. In the appendices are included the text of the ALGOL program MICROFLUX-2, a list of elements and isotopes of which the cross sections are compiled in THERMALIBR and a list of temperatures and isotopes for which the KY matrices are given in THERMALIBR are included. (auth)

23608 ON THE SHAPE OF A NEUTRON BEAM PRODUCED BY MEANS OF THE T(d,n)^{4}He REACTION USING A THICK TARGET AND THE ASSOCIATED-PARTICLE METHOD. Granata, L.; Lagonegro, M. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nucl. Instrum. Methods, 70: 93-7(Apr. 1, 1969).

The shape of a neutron beam produced by means of the T(d,n)^{4}He reaction is analyzed. Taking into account the degradation of the incident deuterons in the target material and the finite aperture of the α-particle detector, the evaluation of the energy spread of the neutron beam, associated with the α-particles, is carried out. The results of a numerical calculation are compared with experimental data. (auth)

23609 SINGLE DIFFERENTIAL CROSS SECTION OF ZIRCONIUM HYDRIDE AT EXTENDED TEMPERATURE. Carriveau, G. W.; Borgonovi, G. M.; Beyster, J. R. (Gulf General Atomic Inc., San Diego, Calif.). Nukleonik, 12: 143-4(Mar. 1969).

The neutron differential scattering cross section of ZrH at 296 and 700°K was measured for incident neutron energies of 0.019 to 0.822 eV in 5° steps. The results were compared with the predictions of the central force lattice dynamical model and the Gaussian-plus-Debye model. Generally good agreement between the experimental results and theoretical predictions from both models was obtained. Near the first and second oscillator levels, the experimental cross section appears smoother than the theoretical cross section at both temperatures. (D.C.W.)

23610 LEAKAGE OF THERMAL NEUTRONS THROUGH BERYLLIUM FILTERS. Webb, F. J. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 69: 325-9(Apr. 1969).

The leakage of thermal neutrons through blocks of polycrystalline beryllium has been computed by the Monte Carlo method. Transmission by multiple scattering is an important factor when short filters and wide collimation angles are employed. Beryllium filters used to provide beams of cold neutrons are usually followed by sufficiently narrow collimation to avoid serious contamination of the transmitted beam with thermal neutrons. However the beryllium detector method has limitations, which are demonstrated. (auth)

23611 METHODS FOR THE DIGITAL SOLUTION OF THE NEUTRON TRANSPORT EQUATION IN THE P$_n$ APPROXIMATION. Pavelescu, M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 20: 747-76(1968). (In Rumanian).

Flux distribution calculations may be carried out on the basis of neutron transport theory by the numerical integration of the equation, using a suitable approximation. The P$_n$ approximation which is applicable to slab, spherical and cylindrical geometries, requires special computing techniques. Some of these numerical methods, developed and currently used in various reactor laboratories, are reviewed, extending the multigroup diffusion technique to the P$_n$ approximation on the basis of the solution proposed by Melville Clark. The methods are able to solve the matrix equation only if a high-speed computer with a large memory is used. The double P$_n$ approximation may be applied to cases involving boundaries with strongly absorbing media. (TTT)

23612 NEUTRON TIME-OF-FLIGHT TECHNIQUES. Bedford, L. A. W.; Dyer, R. F.; Hall, J. W.; Russell, M. C. B. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Eng. Int., 14: 330-7(Apr. 1969).

The principle of neutron time-of-flight techniques, used increasingly for solid-state physics investigations, are reviewed in relation to a typical instrument, the Harwell chopper on the Pluto reactor. Standard drives and neutron rotors, developed for this instrument, and used in many different experiments, are described. (auth)(UK)

23613 NEUTRON ABSORPTION IN SOME MATERIALS USED IN REACTOR DESIGN. Lundgren, Goeran. Abstracts of Uppsala Dissertations in Science, No. 108. Uppsala, Univ. of Uppsala, 1968. 10p.

Thesis.

A review of four articles dealing with neutron absorption in zirconium, ^{93}Nb, uranium, and ^{232}Th is presented. (J.W.R.)

23614 REACTOR NEUTRON PULSE PROPAGATION THROUGH MULTIPLYING MEDIA. Doshi, Pratap Kilachand. Urbana, Ill., Univ. of Illinois, 1968. 170p.

Thesis.

An experimental and theoretical study of neutron pulse propagation in a multiplying medium is described. Experiments used a subcritical assembly constructed with enriched uranium TRIGA-type fuel elements. Placed in the bulk shielding tank, it was coupled neutronically with the Illinois TRIGA reactor through a 2 ft square × 4 ft long graphite thermal column. Thus, the TRIGA reactor served as a source of pulsed neutrons. Experiments were carried out for four different fuel loadings containing 9, 16, 25, and 49 fuel elements giving a variation in K_{eff} from about 0.4 to 0.92. Data were also taken for pure water. Despite the small size of the assembly (29 × 38 × 29 cm), it was possible to determine the "asymptotic" pulse propagation velocity (removed from boundaries) accurately by measuring the flux at 7 locations along the axis of the assembly. The data were analyzed using a polynomial expansion method to interpolate between the discrete data points. A thermal neutron diffusion theory with fast neutron slowing-down represented by an integral slowing-down kernel was used to interpret the data and to gain further insight into the pulse propagation phenomena. Derivatives appearing in the theoretical model were evaluated from the polynomial expansion and then used to determine the propagation velocity and the neutronic parameters of the system. The measured "asymptotic" velocity was found to exhibit a maximum of about 4×10^4 cm/sec at K_{eff} equal to 0.65. At $K_{eff} = 0.92$, the maximum fuel loading condition, it was found to be 2.54×10^4 cm/sec. In general, the experimental results follow the trend predicted by theory. However, the difference in the absolute values of as much as 40% was observed. The discrepancy between the experimental and theoretical results is attributed for the most part to two causes: errors in cross-section data; and heterogeneity effects in the far subcritical region. (Disser. Abstr.)

23615 SLOW NEUTRON FLUX IN MODERATOR CAVITIES OF MONITORS. Trochev, T. (Institut de Physique, Sofia). Acta Phys. Pol., 35: 359-61(Mar. 1969). (In French).

The effects of enlarging the cavity in cylindrical moderators of hydrogenous material on variations of the flux of slow neutrons were studied. It was proven that the flux of neutrons diminishes considerably when the radius of the cavity is enlarged. It is recommended that in the process of fabrication the detectors be embedded in the moderators and, presenting a general effect, that they be included in the monitor system. (tr-auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 23361, 23369, 23418, 23589, and 23789.

23616 ANGULAR DISTRIBUTION OF THE T(p,n)^{3}He REACTION FOR PROTON ENERGIES OF 2.5 AND 3.0 MeV. Peetermans, A. Bull. Soc. Roy. Sci. Liege, 37: 466-73(1968). (In French).

The angular distribution of neutrons from T(p,n)^{3}He reaction was measured from 0 to 140° for proton energies of 2.5 and 3.0 MeV. A methane-filled proportional counter was used. The experimental results have estimated errors within 3–5% and were fitted to Legendre polynomials. Comparison with earlier measurements are presented. (auth)

23617 SINGULAR STATIC POTENTIAL FOR $\alpha-\alpha$ ELASTIC SCATTERING. Treacy, P. B. (Australian National Univ., Canberra). Nucl. Phys., A128: 241-6(1969).

Phase shifts for $\alpha-\alpha$ elastic scattering in the one-channel region can not be fitted with an ordinary static potential; an interaction containing singular components is required. It is found that with such a potential the three lowest levels of ^{8}Be are represented by poles on separate Regge trajectories, which are reminiscent of relativistic daughter trajectories. A five-pole Cheng representation of the scattering phase shifts is described. (auth)

23618 ^{3}He$(\alpha,\gamma)^{7}$Be REACTION AT VERY LOW ENERGY. Nagatani, K.; Dwarakanath, M. R.; Ashery, D. (California Inst. of Tech., Pasadena). Nucl. Phys., A128: 325-32(1969).

Absolute cross sections for the ^{3}He$(\alpha,\gamma)^{7}$Be reaction were determined for center-of-mass energies between 164 and 245 keV. The results are in good agreement with previous values obtained by Parker and Kavanagh, where the experiments overlap. The energy region was extended to lower energies, and the accuracy of the measurement was improved. (auth)

23619 ELASTIC SCATTERING OF FAST NEUTRONS BY DEUTERONS. Bonner, B. E.; Paul, E. B.; Phillips, G. C. (Rice Univ., Houston, Tex.). Nucl. Phys., A128: 183-92(1969).

The differential cross section for the elastic scattering of neutrons by deuterons was measured at neutron energies of 5.64, 7.01, and 9.04 MeV. The ^{2}H(d,n)^{3}He reaction was used as the source of neutrons; the scattering sample was a deuterated benzene scintillator coupled to a photomultiplier tube. Both the time-of-flight of the scattered neutron and the recoil energy deposited in the scatterer scintillator were measured by using fast coincidence techniques and a two-parameter computer analyzer. The data were normalized to the n-p scattering cross section. The relative efficiency of the detector was determined by detecting the neutrons scattered from protons in a normal scintillator. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 23226, 23369, 23648, 23658, 23665, 23771, 23775, 23789, 23794, 23795, and 23797.

23620 (AD-674879) ^{51}V (γ,α) AND ^{51}V $(\gamma,\alpha 3n)$ REACTIONS TO 300 MeV. Meyer, Richard A.; Walters, William B.; Hummel, John P. (Illinois Univ., Urbana). 1968. Contract Nonr-1834(05). 47p. CFSTI.

Yield and cross-section results were obtained for some photonuclear reactions in ^{16}O, ^{19}F, ^{27}Al, and ^{51}V targets by measuring the radioactivities of the product nuclei in samples that has been irradiated with bremsstrahlung in the 20- to 300-MeV energy range. The reactions studied were the ^{16}O $(\gamma,2n)$, ^{19}F $(\gamma,2pn)$, ^{27}Al $(\gamma,2pn)$, ^{51}V (γ,α), and ^{51}V $(\gamma,\alpha 3n)$ reactions. The cross sections at energies above 150 MeV were interpreted in terms of the contributions from various reaction mechanisms. The reactions in O, F, and Al generally have important contributions from both quasi-deuteron and pion emission processes. In the ^{51}V reactions, an additional mechanism, pion reabsorption, also makes important contributions. The reaction cross sections at energies below 150 MeV are used to determine the total cross sections for photon absorption at energies above the giant resonance region and below 150 MeV. The resulting total cross sections are generally consistent with those determined from neutron counting experiments. (auth)(USGRDR)

23621 (ANU-P-430) THE SPIN OF THE 2.78-MeV STATE IN ^{19}Ne. Baugh, D. J.; Nurzynski, J.; Rosalky, D. M.; Osman, C. H. (Australian National Univ., Canberra. Research School of Physical Sciences). [1968]. 9p. Dep.

The reaction, ^{20}Ne(^{3}He$,\alpha)^{19}$Ne, was studied at 10- and 15-MeV bombarding energy. A DWBA analysis was performed indicating an $l = 4$ or $l = 5$ transition to the 2.78-MeV state in ^{19}Ne. (auth)

23622 (ANU-P-432) DEUTERON INDUCED REACTIONS IN ^{12}C AT BOMBARDING ENERGIES OF 5 TO 10 MeV. Cords, H.; Din, G. U.; Robson, B. A. (Australian National Univ., Canberra. Research School of Physical Sciences). [1968]. 61p. Dep.

Absolute differential cross sections for the reactions ^{12}C(d,p)^{13}C leading to the ground state and the 3.09-, 3.68-, and 3.85-MeV excited states; ^{12}C$(d,\alpha)^{10}$B for the ground state and 0.717-MeV residual level; and the elastic scattering of deuterons on ^{12}C were measured for bombarding energies of 5 to 10 MeV. An analysis of these measurements was performed using the optical model and the distorted-wave and Hauser-Feshbach theories. (auth)

23623 (ANU-P-433) ENERGY-DEPENDENCE OF THE ^{16}O(^{3}He,^{3}He)^{16}O AND THE ^{16}O(^{3}He$,\alpha_0)^{15}$O ANGULAR DISTRIBUTIONS IN THE RANGE 9.8 TO 11.7 MeV. Bray, K. H.; Nurzynski, J. (Australian National Univ., Canberra. Research School of Physical Sciences). [1968]. 26p. Dep.

Angular distributions of the ^{16}O(^{3}He,^{3}He)^{16}O and the ^{16}O(^{3}He$,\alpha_0)^{16}$O reactions were measured at the incident ^{3}He particle energies of 9.802, 9.955, 10.210, 10.313, 10.465, 10.720, 11.229, and 11.738 MeV. While the distributions for the elastic scattering are similar at all energies, the shape of the differential cross section for the ^{16}O(^{3}He$,\alpha_0)^{15}$O reaction exhibits a strong energy dependence at angles $\theta \gtrsim 60°$. At forward angles the (^{3}He$,\alpha$) distributions display some characteristics of direct pick-up transition, i.e., a rise in the differential cross section and a regular diffraction structure. The data were analyzed in terms of the optical model and distorted-wave Born approximation theory. (auth)

23624 (AWRE-O-60/68) THE CROSS SECTION FOR THE ^{16}O$(n,\alpha)^{13}$C REACTION FOR NEUTRON ENERGIES IN THE RANGE 7 TO 12 MeV. Dandy, D.; Wankling, J. L.; Parnell, C. J. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct. 1968. 14p. Dep. CFSTI. UK 2s. 6d.

The cross sections for the reactions ^{16}O$(n,\alpha)^{13}$C and ^{16}O$(n,\alpha_0)^{13}$C were measured in the neutron energy range from 8 to 12 MeV using monoenergetic neutrons. Absolute determinations of these cross sections were not made, but the results were normalized to existing data in the neutron energy range 7 to 8.7 MeV. (auth) (UK)

23625 (NP-17768) NUCLEAR STRUCTURE INVESTIGATION WITH THE DARMSTADT 60-MeV ELECTRON LINEAR ACCELERATOR. An Activity Report. (Technische Hochschule, Darmstadt (West Germany). Institut fuer Technische Kernphysik). Dec. 1967. 149p. (In German). Dep.

Studies made on electron scattering, inelastic electron scattering, nuclear photoeffect, nuclear spectroscopy with radioactive nuclides, and the Moessbauer effect are discussed in detail. The nuclear radii of Be and C were determined. The elastic effective cross sections of ^{46}Ti, ^{48}Ti, and ^{50}Ti were compared. Inelastic electron scattering measurements were made for ^{9}Be, ^{16}O, ^{6}Li, ^{7}Li, ^{10}B, ^{11}B, ^{12}C, ^{14}N, ^{15}N, ^{24}Mg, ^{26}Mg, ^{28}Si, ^{46}Ti, ^{48}Ti, and ^{50}Ti. Photoproduction of ^{7}Be from ^{9}Be, ^{10}Be, ^{11}B, C and O was investigated. Experimental and theoretical (γ,t) yields on C, O, Al, Co, Ni, Cu, Pd, Ag, Cd, In, Sn, and Sb are reported. Photoreactions on ^{59}Co at 35 and 55 MeV are tabulated. The preparation of radioactive isotopes for nuclear spectroscopy measurements and the measurement methods used are described. Results are reported for the nuclear spectroscopy of γ reactions on ^{45}Sc, ^{68}Ga, ^{142}Nd, ^{154}Sm, ^{173,174,175,176}Yb, and ^{174}Hf. Half-life measurements were made on excited states of ^{152}Sm, ^{154}Gd, ^{156}Gd, ^{158}Gd, and ^{166}Er. Hyperfine structure measurements were made on rare earth isotopes using the Moessbauer effect. (J.S.R.)

23626 (NP-17794) CONTRIBUTION TO THE STUDY OF THE INTERACTION OF FAST NEUTRONS WITH 1p, 2s, 1d NUCLEI. Roturier, Jacques (Bordeaux Univ. (France). Faculte des Sciences). 1968. 228p. (In French). Dep.

Thesis.

Elastically and inelastically scattered neutrons and γ rays that result from the interaction of fast neutrons with light nuclei (1p, 2s – 1d) were studied. The fast neutrons were produced with the d + T reactions and were studied with a time-of-flight spectrometer. The elastic scattering of neutrons from Be, Si and K was measured. While analyzing the results, the other available data were taken into account. These data were analyzed using Dar's diffraction model, and an interpretation is proposed for the parameter deduced. The non-local potential optical model was used to calculate cross sections; and results are presented for Be, Al, Si, K, and Ca. There is an indication of compound elastic contribution in the case of Be which was studied with the Hauser–Feshbach theory. The inelastic scattering data for ^{9}Be(n,n')^{9}Be ($Q = -2.43$ MeV) and ^{12}C(n,n')^{12}C ($Q = -4.43$ MeV) give good fit with the values obtained from the coupled-channel theory of Tamura. The relation between $\sigma_{n,n'}$ and B(E2) was investigated using the expressions given by Benetskii and Franck, Arya, et al.; the existing results for Be, C, O, Mg, Si, S, and Ca were taken into account. Gamma spectra from the $(n,x\gamma)$ and (n,γ) reactions were studied. In the case of $(n,n'\gamma)$ reaction, it was found that for 1 p nuclei the cross sections $\sigma_{n,n'\gamma}$ and $\sigma_{n,n'}$ are quite similar, but for the 1d – 2s nuclei, the former is from 2 to 4 times higher than the latter; there exists a quasicontinuous γ-ray spectrum. It is proposed that this results from the disintegration of the highly excited residual compound nucleus that results from the evaporation of one neutron. The cross section σ^{n}_{NC} for this process is calculated. The process of radiative capture was studied; special attention was paid to the interpretation of the γ-ray spectrum of the ^{28}Si (n,γ) reaction. The process of semi-direct capture as proposed by Brown gives the best fit to the experimental data. For other nuclei (Be, C, Na, K) the values of the capture cross section were determined by integrating the γ-ray spectrum. The values of capture cross sections for Be and C are low but close to the one found for the ^{1}H (n,γ) ^{2}H reaction. In the case of ^{23}Na and ^{39}K, the cross sections are lower than the results obtained from the activation measurements by Perkins and et al., and Csikai and et al.; but the difference becomes smaller with the increase in the value of mass number A. (auth)

23627 (SLAC-Trans-92) PHOTOPRODUCTION OF NEUTRAL VECTOR ρ^0 AND ϕ MESONS IN THE FORWARD DIRECTION AT VARIOUS ATOMIC NUCLEI. Becker, Ulrich (Hamburg Univ. (West Germany)). Translated by L. B. Kapp for Stanford Linear Accelerator Center, Calif., from a German thesis. 118p. Dep. CFSTI.

The reactions $\gamma + A \rightarrow \rho^0 + A$ and $\gamma + A \rightarrow \phi + A$ were investigated at γ energies of 2.7 to 4.5 GeV and 4.0 to 6.2 GeV in the region of small angles, $\delta < 6°$, with respect to the γ beam on targets of Be, C, Al, Cu, Ag, and Pb. Measurements at various momenta showed that the effective total cross section is constant, in contradiction with the one-pion-exchange model. On the other hand, the data were described quite well by the diffraction-dissociation model. The mass and width of the ρ^0 meson were found to be 765 ± 5 and 130 ± 5 MeV/c^2, respectively. The effective total cross sections for the interations ρ^0 + N and ϕ + N were determined using the model of Drell and Trefil; the results are in agreement with the predictions of the quark model. The coupling coefficients of the vector dominance model were determined using the effective cross sections. The ρ^0 coupling constant is in good agreement with values obtained by other methods. (D.C.W.)

23628 ^{16}O(γ,n$_0$)^{15}O CROSS SECTION BETWEEN 35 AND 65 MeV. Nagle, P. C.; Winhold, E. J.; Yergin, P. F.; Stoler, P.; Mecca, S. J. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Phys., A127: 669-72(1969).

The 67.5° ground-state cross section for ^{16}O(γ, n$_0$)^{15}O was measured for the photon energy range of 35 to 65 MeV. The results indicate no strong structure. In addition, the cross section to the 6.16-MeV state in ^{15}O was measured with less certainty. (auth)

23629 GAMMA-RAY BRANCHING OF THE 3.59-MeV STATE OF ^{10}B. Galloway, R. B.; Vass, D. G. (Univ. of Edinburg). Nucl. Phys., A127: 538-44(1969).

A γ-neutron coincidence time-of-flight spectrometer was used to observe the gamma-ray spectrum following the formation of the 3.59-MeV state of ^{10}B in the ^{9}Be(d, nγ)^{10}B reaction. The relative probabilities of gamma-ray transitions to the ground, 0.72-, and 2.15-MeV states were determined as 19 ± 4%, 70 ± 7%, and 11 ± 2%, respectively. An upper limit of 1% is set on the intensity of the 3.59 → 1.74 MeV transition. (auth)

23630 SPECTROSCOPIC FACTORS DERIVED FROM ^{16}O(d, n)^{17}F MEASUREMENTS. Oliver, C. J.; Forsyth, P. D.; Hutton, J. L.; Kaye, G.; Mines, J. R. (Liverpool Univ.). Nucl. Phys., A127: 567-76(1969).

Angular distributions of the ^{16}O(d, n)^{17}F reaction leading to the ground and first excited states of ^{17}F were determined at deuteron bombarding energies of 7.73, 11 and 12 MeV. DWBA calculations yield spectroscopic factors consistent with the expected values for these states. These spectroscopic factors correspond closely with those obtained from comparison studies of the mirror ^{16}O(d, p)^{17}O reaction in which the same deuteron optical model parameters were used. (auth)

23631 ENERGY DEPENDENCE OF THE ^{16}O(^{3}He,^{3}He)^{16}O AND THE ^{16}O(^{3}He,α_0)^{15}O ANGULAR DISTRIBUTIONS IN THE RANGE 9.8 TO 11.7 MeV. Bray, K. H.; Nurzynski, J. (Australian National Univ., Canberra). Nucl. Phys., A127: 622-34(1969).

Angular distributions of the ^{16}O(^{3}He, ^{3}He)^{16}O and the ^{16}O(^{3}He, α_0)^{16}O reactions were measured at the incident ^{3}He particle energies of 9.802, 9.955, 10.210, 10.313, 10.465, 10.720, 11.229, and 11.738 MeV. While the distributions for the elastic scattering are similar at all energies, the shape of the differential cross section for the ^{16}O(^{3}He, α_0)^{15}O reaction exhibit a strong energy dependence at angles $\theta \geqq 60°$. At forward angles, the (^{3}He, α) distributions display some characteristics of direct pick-up transition, i.e., a rise in the differential cross section and a regular diffraction structure. The data were analyzed in terms of the optical model and distorted-wave Born approximation theory. (auth)

23632 EXCITATION OF THE 0^- LEVEL AT 3.56 MeV IN ^{6}Li BY (p,p) SCATTERING AT 14 TO 16 MeV. Merchez, F. (Institut des Sciences Nucleaires, Grenoble, France); Bouchez, R.; Hoffswell, R. A.; Yavin, A. I. J. Phys. (Paris), 29: 969-72 (Nov.-Dec. 1968). (In French).

Elastic and inelastic scattering of protons from ^{6}Li was studied at proton energies of 14 to 16 MeV. The total and differential cross sections for the weak $\Delta T = 1$ transition to the 0^+ state at 3.56 MeV were compared with the analogue $\Delta T = 1$ transitions in the reactions ^{6}Li(n,p)^{6}He and ^{6}Li(p,n)^{6}Be. (auth)

23633 PARTIAL CAPTURE RATES OF MUON BY ^{16}O LEADING TO EXCITED NUCLEAR STATES OF ^{15}N. Kaplan, S. N.; Pyle, R. V.; Temple, L. E.; Valby, G. F. (Univ. of California, Berkeley). Phys. Rev. Lett., 22: 795-8(Apr. 14, 1969).

Partial interaction rates were measured for the muon capture reactions $\mu^- + {}^{16}O \rightarrow {}^{15}N^* + n + \nu$ leading to the excited states at 6.323 MeV ($\frac{3}{2}^-$), 5.270 MeV ($\frac{5}{2}^+$), and 5.299 MeV ($\frac{1}{2}^+$). The total observed transition rate to excited states of ^{15}N is in good agreement with predictions attending recent calculations of the total capture rate. The distribution of the excitation among the three levels is very similar to that observed from the photoproton and photoneutron reactions on ^{16}O. (auth)

23634 THE REACTION ^{11}B(d,α)^{9}Be IN THE ENERGY REGION OF 0.7 TO 2.2 MeV. Friedland, E.; Verleger, H. (Univ. of Pretoria). Z. Phys., 222: 138-43(1969). (In German).

Excitation functions were measured from 0.7 to 2.2 MeV for the α_0, α_1, α_2, and α_3 groups at an angle of $\theta_L = 90°$. Two broad maxima were found in all four cases, suggesting the existence of resonances in the ^{13}C compound nucleus. A problem, however, arises, as the first maximum appears at a bombarding energy of 1.15 MeV for the α_0 and α_1 groups, while it is shifted to 1.35 MeV in the excitation curves for the α_2 and α_3 groups. The second maximum appears at 1.85 MeV in all curves. Angular distributions were measured at 7 energies between 1.0 and 2.2 MeV for the α_0 and α_2 transitions. The coefficients of the first four Legendre polynomials, describing these distributions, are given. (auth)

23635 MEASUREMENT OF MUON PARTIAL CAPTURE RATES IN ^{16}O AND THE INDUCED PSEUDOSCALAR COUPLING CONSTANT IN MUON CAPTURE. Deutsch, J. P.; Grenacs, L.; Lehmann, J.; Lipnik, P.; Macq, P. C. (Univ., Louvain, Belg.). Phys. Lett., 29B: 66-9(Mar. 31, 1969).

The partial rates in the capture of muons by ^{16}O were measured for the $J^\pi = 0^-$ and 1^- excited bound states of ^{16}N. The energy spectrum and the time dependence of the γ-rays emitted by the target were observed using a Ge(Li) detector. On the basis of the Rho–Migdal theory, the observed λ_0-/λ_1-ratio led for the induced pseudoscalar coupling to a value of $C_P = 10.6 \pm 1.0$. (auth)

23636 "Ab Initio" CALCULATION OF THE QUADRUPOLE COUPLING CONSTANT OF ^{14}N IN HCN, FCN, ClCN, HC$_2$CN, CN-, OCN-, SCN-, AND THE EXAMINATION OF THE TOWNES–DAILEY INTERPRETATION IN TERMS OF EXCLUSIVE ORBITALS. Bonaccorsi, Rosanna; Scrocco, Eolo; Tomasi, Jacopo (Univ., Pisa, Italy). J. Chem. Phys., 50: 2940-8(Apr. 1, 1969).

The electric field gradient at ^{14}N nucleus in some RCN molecules or RCN$^-$ ions was calculated using the accurate SCF wave functions obtained by McLean and Yoshimine. From these computed values and the experimentally known ^{14}N quadrupole coupling constant of four molecules of this series, a value of 1.66 e × 10^{-26} cm^2 for the quadrupole moment of ^{14}N nucleus was estimated. A check for the semiempirical interpretative theory of Townes and Dailey is made in terms of localized orbitals (Boys exclusive orbitals). Some other characteristics of these exclusive orbitals are also displayed. (auth)

23637 ALPHA–DEUTERON STRUCTURE OF THE ^{6}Li GROUND STATE. Truoel, P.; Bierter, W. (Univ. of California, Berkeley). Phys. Lett., 29B: 21-4(Mar. 31, 1969).

A simple pole model for the elastic scattering of α particles on ^{6}Li is described. The ground state of ^{6}Li consists of a deuteron weakly bound to an α particle. The angular distributions were calculated, and comparison with the experimental data yields a value for the coupling constant of the ^{6}Li-α-d vertex. (auth)

23638 A STUDY OF THE $T = \frac{3}{2}$ STATES OF ^{17}O. Detraz, C; Duhm, H. H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 29B: 29-32(Mar. 31, 1969).

Eight analogue $T = \frac{3}{2}$ excited states in ^{17}O were identified with the ^{18}O(^{3}He,α)^{17}O reaction at E(^{3}He) = 16 MeV. The l-transfer values and spectroscopic factors are presented for four of these states. (auth)

23639 CORRELATION BETWEEN NUCLEAR RADII AND BINDING ENERGIES FOR LIGHT NUCLEI. Angeli, I. (Kossuth Univ., Debrecen, Hungary); Csikai, J.; Hunyadi, I. Phys. Lett., 29B: 36-7(Mar. 31, 1969).

Deviations of measured total neutron cross sections from the "black-nucleus" formula were investigated for light nuclei. Similar trends in electrical charge radii suggest that the deviations are caused by variations in the nuclear radius parameter, r_o. It was found that a correlation exists between r_o and the binding energy per nucleon, ϵ, namely r_o(fm) ≈ ϵ^{-1}(MeV). (auth)

23640 LEVELS IN ^{15}N RESULTING FROM THE PROTON CAPTURE OF ^{14}C. Siefken, H. E.; Cockburn, P. M.; Krone,

R. W. (Univ. of Kansas, Lawrence). Nucl. Phys., A128: 162-82(1969).

The gamma-ray decay of the ^{14}C(p,γ)^{15}N resonances at E_p = 352, 527, and 634 keV was extensively studied. Spins of J = $\frac{5}{2}$ and J = $\frac{3}{2}$ were assigned to the upper and lower levels of the 9.16 MeV doublet respectively on the basis of angular correlation measurements. Similar measurements show the spin of the 8.31-MeV level to be J = $\frac{1}{2}$. Mixing ratios for most of the gamma-ray transitions were also determined. (auth)

23641 CHARGE FORM FACTOR OF ^{6}Li. Jain, S. C. (Allahabad Univ., India). Z. Phys., 222: 222-4(1969).

The charge form factor of ^{6}Li was calculated using an exponential type of wave function to describe its ground state. The value of the parameter in the wave function was obtained by fitting the root-mean-square radius for the above wave function to the experimental value. The calculated charge form factor is in excellent agreement with those obtained from electron scattering experiments. This shows that the wave function for ^{6}Li is quite satisfactory. (auth)

23642 T = $\frac{3}{2}$ STATES IN A = 13 AND A = 17 NUCLEI. Van Bree, Richard George. New Brunswick, N. J., Rutgers–The State Univ., 1968. 176p.

Thesis.

An investigation of the lowest-lying T = $\frac{3}{2}$ state in ^{13}N was undertaken using the isospin-forbidden compound nucleus reaction ^{12}C + p → ^{13}N*. This state was observed as a resonance in the elastic excitation curve, at an excitation energy of 15.047 ± 0.02 MeV in ^{13}N, having an observed total width of 3 keV. In addition, this resonance was also observed in the yield of protons to the 2^+ and 0^+ excited states of ^{12}C, as well as the alpha particle yield to the ground and first excited states of ^{9}B. An R-matrix analysis of the data was performed which resulted in the spin-parity assignment of $\frac{3}{2}^-$ for this state. The total width was evaluated to be equal to 1.55 keV and the ratio Γ_p/Γ = 0.18 was determined. All data are in excellent agreement with the isospin-allowed pickup and stripping reactions. Theoretical calculations are underway to determine the width of this state. In a similar manner, the formation of T = $\frac{3}{2}$ states in ^{17}F was undertaken using the isospin-forbidden ^{16}O + p → ^{17}F* reaction. A slight resonance was observed at the position expected for the ground state analog of ^{17}N, corresponding to an excitation energy of 11.196 ± 0.007 MeV in ^{17}F. The R-matrix analysis revealed that the width of this state is 500 eV, the partial proton width being 50 eV. The resonance could be fitted with spin-parity choices of either $\frac{1}{2}^-$ or $\frac{3}{2}^-$. The next T = $\frac{3}{2}$ state was observed at an excitation energy of 12.557 ± 0.007 MeV, having a total width of 1.8 keV, a partial proton width of 540 eV, and a spin-parity of $\frac{3}{2}^-$. Higher T = $\frac{3}{2}$ states were located at excitation energies of 13.066, 14.180, and 14.312 MeV. The state at 13.066 MeV appears as two overlapping resonances having widths of 3 and 10 keV. It is concluded that the 3 keV state has spin-parity $\frac{5}{2}^-$, $\frac{7}{2}^-$. The spins, parities, and locations of all these states agree well with the results of an isospin-allowed (^{3}He,n) experiment locating these states, as well as the predicted locations based on the energy level structure of ^{17}N, the parent nucleus (T_z = $\frac{3}{2}$). The widths of the states at 14.180 and 14.312 MeV are 50 and 15 keV, respectively. This is probably a consequence of the fact that the allowed T = 1 proton decay channels are energetically accessible to these states. Calculations were performed to evaluate the coefficients in the isobaric mass formula for A = 4n + 1 type nuclei from A = 9 to A = 41. Using these coefficients, it is possible to calculate the mass of $T_z = -\frac{3}{2}$ nuclei. Agreement with experimental measurements has been remarkably good, indicating that electromagnetic interactions are wholly responsible for departures from isospin invariance. The results of these studies also show that accurate values of Coulomb displacement energies may be obtained, and in general, agree to within ±150 keV with the energies calculated by using a uniformly charged-sphere model for the nucleus. (Disser. Abstr.)

23643 THE NUCLEAR STRUCTURE OF ^{18}F. Polsky, Lawrence Manuel. Philadelphia, Univ. of Pennsylvania, 1968. 97p.

Thesis.

An experimental program was undertaken to clarify the structure of ^{18}F by confirming or establishing the quantum numbers of some of the low lying levels and obtaining quantitative information on their wave functions. The program involved the study of the three reactions ^{17}O(^{3}He,d)^{18}F, ^{16}O(^{3}He,p)^{18}F, and ^{20}Ne(d,α)^{18}F. The reactions were induced with 15-MeV ^{3}He^{2+} and 11-MeV d$^+$ beams from a Model EN Tandem Van de Graaff accelerator, and reaction products were magnetically analyzed in a 65-cm. pole radius magnetic spectrograph. Angular distributions of the transitions to 10 final states were obtained in the ^{17}O(^{3}He,d)^{18}F study and the angular momentum transfers involved were determined by comparison of the experimental results with DWBA predictions. The DWBA analysis also yielded spectroscopic factors which were found to be in good agreement with recent theoretical predictions. The ^{16}O(^{3}He,p)^{18}F study yielded angular distributions of the transitions to 14 final states in ^{18}F. Approximate DWBA calculations were performed assuming the two nucleons to be transferred as a correlated pair, and comparison of the calculated and experimental angular distributions allowed the angular momentum transfers of seven of the transitions to be identified. These results were also compared to theoretical predictions and found to be in good agreement. The six T = 1 analogues of ^{18}O states expected to lie below 6-MeV in ^{18}F were identified with the isospin selective ^{20}Ne(d,α)^{18}F reaction. New spin and parity assignments were made to seven ^{18}F levels and the ground state, 0.94-, 1.04-, 1.13-, 3.06-, 3.84-, 4.12-, 4.65-, 4.74-, and 4.96-MeV levels were identified as being primarily composed of (sd)^2 configurations. Evidence was also obtained that the two positive parity levels at 1.70- and 2.52-MeV are not formed of configurations in the (sd) shell. (Disser. Abstr.)

23644 MEASUREMENT OF NUCLEAR LIFETIMES BY THE DOPPLER ATTENUATION SHIFT METHOD. Thomas, Jess Brooks Jr. Stanford, Calif., Stanford Univ., 1968. 84p.

Thesis.

The Doppler shift attenuation method, including centroid and shape analyses, was developed in detail. The lifetimes of the ^{7}Li(478), ^{7}Be(432), ^{8}Li(980), ^{10}B(2150), and ^{13}C(3850) levels were measured with the Doppler shift attenuation method and lithium-drifted germanium detectors. The associated radiation widths were compared in each case with the widths predicted by shell model theory. Agreement with the theoretical predictions is excellent for the ^{7}Li(478) and ^{8}Li(980) levels and fair for the ^{7}Be(432), ^{10}B(2150), and ^{13}C(3850) levels. (Disser. Abstr.)

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Refer also to abstracts 21756, 21777, 22067, 22080, 22090, 23226, 23620, 23625–23627, 23639, 23746, 23757, 23760, 23771, 23794, 23795, 23797, and 23803.

23645 (AD–675038) ELECTRON SCATTERING STUDIES OF CALCIUM AND TITANIUM ISOTOPES. Frosch, R. F.; Hofstadter, R.; McCarthy, J. S.; Noldeke, G. K.; van Oostrum, K. J. (Stanford Univ., Calif. High-Energy Physics Lab. General Motors Research Labs., Warren, Mich. Illinois Univ., Urbana. Dept. of Physics). 1968. Contract Nonr-225(67). 85p. (HEPL–554). CFSTI.

Experimental results are presented on the scattering of 250-MeV electrons by ^{40}Ca, ^{42}Ca, ^{44}Ca, ^{48}Ca, and ^{48}Ti, and 500-MeV electrons by ^{40}Ca and ^{48}Ca. An analysis is made in terms of a phenomenological three-parameter shape, and a new, more accurate charge distribution is obtained for ^{40}Ca. The experiments also lead to a detailed exploration of the radial dependence of the differences in charge distributions of the various isotopes. Implications for nuclear theory are discussed. Comparison is made with the results of other electron scattering and of muonic x-ray experiments. The latter comparison permits an independent determination of an upper limit on the muon electromagnetic radius. (auth)(USGRDR)

23646 (ANU-P-428) ANGULAR-CORRELATION STUDIES OF THE REACTION ^{24}Mg(α,pγ)^{27}Al. Carter, K. W.; Elliott, R. V.; Kean, D. C.; Spear, R. H. (Australian National Univ., Canberra. Research School of Physical Sciences). [1968]. 24p. Dep.

The 3.68-, 3.96-, 4.05-, and 4.58-MeV levels of ^{27}Al were studied via angular correlation measurements of the reaction ^{24}Mg(α,pγ)^{27}Al. The results are used in conjunction with previous information on lifetimes and branching ratios to impose limitations on possible spins, parities, and multipole mixing ratios. New information on the gamma-ray decay scheme of the 4.58-MeV level is presented. (auth)

23647 (INFN/BE–66/9) THE (n,d) REACTION ON Cu AND Zn ISOTOPES. Chursin, G.; Fazio, M.; Micheletti, S.; Pignanelli, M.; Zetta, L. (Istituto Nazionale di Fisica Nucleare, Milan (Italy)). Sept. 12, 1966. 10p. Dep.

Deuteron energy spectra and angular distributions from the (n,d) reaction on the isotopes ^{65}Cu and ^{66,68}Zn initiated by 14-MeV neutrons are given. The angular distributions are fitted with DWBA, and the results are interpreted in terms of the Cu isotopes structure as predicted by the unified model. (auth)

23648 (RLO–1388-94) SPIN FLIP IN THE INELASTIC SCATTERING OF PROTONS. Kolasinski, W. A.; Eenmaa, J.; Schmidt,

F. H.; Sherif, H.; Tesmer, J. R. (Washington Univ., Seattle. Dept. of Physics). [1968]. 32p. Dep. CFSTI.

Proton spin-flip probabilities and differential scattering inelastic cross sections were measured over a large angular region for the following 2^+ excitations: 4.44 MeV in ^{12}C at 12, 13, 14, 15, and 20 MeV; 1.45 MeV in ^{58}Ni at 9.25, 10.46, 15 and 20 MeV; 1.33 MeV in ^{60}Ni at 10.5 and 14 MeV; and 1.34 MeV in ^{64}Ni at 10.5 and 14 MeV. The results were analyzed in the distorted-waves Born approximation, with collective model form factors derived from the optical model potential. The deformed spin-dependent part of the coupling potential was of the full Thomas form, and the data are best described when $\beta_2^{SO} > \beta_2$. Good fits are obtained for elastic polarization data (obtained elsewhere) when the depth of the spin-orbit potential is determined from spin-flip probability measurements. (auth)

23649 STUDY OF THE LEVELS OF ^{57}Co UP TO 1.90 MeV. Dayras, R.; Cujec, B. (Univ. Laval, Quebec). Nucl. Phys., A127: 545-59(1969). (In French).

The ^{57}Co levels were excited through the reaction $^{54}Fe(\alpha,p)^{57}Co$ at 10.23 MeV and 10.30 MeV incident energies. The coincidence gamma-ray spectra were observed with a Ge(Li) detector and the angular correlations $(\alpha p,\gamma)$ are measured in the Litherland–Ferguson geometry for the 1.22, 1.68, and 1.75 MeV levels. The following results are obtained: 1.22 MeV level $J^\pi = {}^9\!/_2^-$, 1.68 MeV level $J^\pi = {}^{11}\!/_2^-({}^9\!/_2^-)$. The corresponding E2/M1 amplitude mixing ratio for the transition 1.22 MeV → 0 is −0.22, and for the transition 1.68 MeV → 1.22 MeV it is 0.00 (0.9). A transition 1.90 MeV → 1.22 MeV is observed in addition to the transition 1.90 MeV → 0. It is concluded that the levels at 1.75 MeV and 1.90 MeV are doublets. (auth)

23650 DIRECT MEASUREMENT OF THE DECAY ENERGY OF ^{85}Sr FROM INNER BREMSSTRAHLUNG SPECTRUM AND BAHCALL EXCHANGE CORRECTION. McDonnell, Michael; Ramaswamy, M. K. (Fordham Univ., New York). Nucl. Phys., A127: 531-7(1969).

The decay energy for electron capture decay of ^{85}Sr was obtained directly by a measurement of the inner bremsstrahlung endpoint energy. The value of 1007 ± 30 keV is in disagreement with the value of 1110 ± 30 keV deduced from the $^{85}Rb(p,n)^{85}Sr$ reaction threshold. The measured value of 478 ± 30 keV for the Q-value to the 514 keV excited level of ^{84}Rb when combined with the measured L/K ratio of 0.12 ± 0.05 yields a correction factor of 1.13 ± 0.17 using Rose's theory or 1.11 ± 0.18 using the most recent calculations of Winter based on the Hartree–Fock wave functions of Watson and Freeman. These values are to be compared with the Bahcall exchange correction factor of 1.09. (auth)

23651 DELAYED PROTONS FOLLOWING THE DECAY OF ^{40}Sc. Verrall, R. I.; Bell, R. E. (McGill Univ., Montreal). Nucl. Phys., A127: 635-40(1969).

Delayed protons were observed following the beta decay of ^{40}Sc to excited states of ^{40}Ca. The observation of these low-energy protons was made possible by using a very thin gas counter as a "dE" detector. Eighteen proton groups between the energies of 1.08 and 3.95 MeV were resolved in the proton spectrum and their energies were measured to ≈ 30 keV. The relative intensities of these peaks were determined and relative log ft values were calculated. (auth)

23652 HALF-LIFE ALTERATIONS PRODUCED BY CHEMICAL MEANS IN ELECTRON-CAPTURE-DECAYING ^{64}Cu. Kemeny, P. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 901-4(1968).

Small half-life alterations due to chemical effects in three different copper compounds, representing three different types of chemical bonds, were investigated. (D.C.W.)

23653 THE YIELDS OF PHOTONUCLEAR REACTIONS IN TITANIUM AND VANADIUM WITH BREMSSTRAHLUNG UP TO 60 MeV. Oka, Yoshinaga; Kato, Toyoaki; Sato, Nobuyoshi (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 42: 387-93(Feb. 1969).

The yields of a number of radioactive nuclei produced by $(\gamma,xnyp)$ reactions on titanium and vanadium targets were determined at bremsstrahlung maximum energies of 30, 45, 55, and 60 MeV, with the aid of radiochemical methods and gamma-ray spectrometric measurements. The linear electron accelerator of Tohoku University was the bremsstrahlung source. Yields were expressed as production rates of given radioactive end-products relative to that of the $^{12}C(\gamma,n)^{11}C$ process. Over the range of energies investigated, the yield of each nuclide increases with increasing maximum energy. The yield of a reaction with the emission of more than one nucleon appeared to be strongly energy dependent. Reaction paths leading to the formation of each nuclide were investigated. The photoproduction of ^{47}Ca from titanium was observed. (auth)

23654 THE $^{32}S(p,\gamma)^{33}Cl$ REACTION. Gordon, James Wylie. Lawrence, Kan., Univ. of Kansas, 1968. 151p.

Thesis.

The present study of the $^{32}S(p,\gamma)^{33}Cl$ reaction was prompted by the apparent absence of certain low-lying states of ^{33}Cl, the knowledge of whose properties is believed to be important for model calculations in this mass region. These "missing" states should be the analogues of those known in the mirror nucleus, ^{33}S, at 1965, 2315, 2937, and 2970 keV. The excitation function of the $^{32}S(p,\gamma)^{33}Cl$ reaction was examined in detail with Ag_2S targets enriched to 99.1% in ^{32}S for proton bombarding energies from 475 to 3215 keV. Resonances at E_p = 580, 587, 1755, 1900, 2227, 2257, 2547, 2636, 2811, 2918, and 3095 keV were identified in the $^{32}S(p,\gamma)^{33}Cl$ reaction. Resonance structure in the gamma-ray yield at E_p = 2902 and 3195 keV was attributed entirely to the $^{32}S(p,p'\gamma)^{32}S$ reaction. Analysis of the gamma-ray spectra taken at the E_p = 2811, 2902, and 2918 keV resonances indicated radiative capture occurring at a broad resonance in this energy region. This was attributed to proton capture at the 360-keV wide state at E_p = 2895 keV known from the proton scattering work of Olness, Haeberli and Lewis. Gamma rays were detected with 12.7 cm × 12.7 cm and 22.9 cm diam by 10.2 cm thick NaI(Tl) scintillation crystals and with a 15-cc coaxially drifted Ge(Li) detector. Decay schemes for each of the resonances above E_p = 1755 keV were proposed from analysis of the gamma-ray spectra and from coincidence measurements. These spectra established the existence of states in ^{33}Cl at excitation energies of 1990, 2347, (2650) and 2979 keV; the state at 2650 keV is populated, weakly, at only one resonance. The energies of these states are in excellent agreement with values reported recently by Moss from studies of the $^{32}S(^3He,d)^{33}Cl$ and $^{36}Ar(p,\alpha)^{33}Cl$ reactions. Resonance strengths were obtained from the decay schemes and excitation function. Angular distribution measurements resulted in the spin assignments $J = {}^5\!/_2$ or ${}^7\!/_2$ for the E_x = 1990-keV state; ${}^5\!/_2$ or ${}^7\!/_2$, 2979 keV; ${}^3\!/_2$ or ${}^5\!/_2$, 3986 keV; ${}^3\!/_2$, 4127 keV; ${}^1\!/_2$ or ${}^3\!/_2$, 4440 keV; ${}^3\!/_2$, 4474 keV; ${}^5\!/_2$, 4757 keV; ${}^3\!/_2$, 4844 keV; ${}^5\!/_2$ or ${}^7\!/_2$, 5099 keV; and ${}^5\!/_2$, 5285 keV. Mixing ratios were determined for most of the primary and secondary members of the gamma-ray cascades. The characteristics of the states at 1990, 2347, 2650, and 2979 keV strongly suggest that these are the analogues of the levels at 1965, 2315, 2937, and 2970 keV, respectively, in ^{33}S. (Disser. Abstr.)

23655 A STUDY OF THE $^{34}S(p,\gamma)^{35}Cl$ REACTION. Ahlgren, H.; Dubois, J.; Linusson, H. (Chalmers Univ. of Tech., Goteborg). Ark. Fys., 38: 585-92(1969).

Upper limits of 300 eV for the total widths were established for the 1214-, 1226-, and 1267-keV resonances in the $^{34}S(p,\gamma)^{35}Cl$ reaction and 500 ± 200 eV for the 1019-keV resonance. The gamma-ray spectrum at the 1267-keV resonance was reinvestigated using a Li-drifted Ge detector. An absolute intensity calibration of the full energy peak for the Ge detector was also performed. (auth) (SWEDEN)

23656 STEADY-STATE NUCLEAR DOUBLE-RESONANCE DETECTION OF ELECTRIC QUADRUPOLE MOMENT OF ^{40}K. Jones, E. P.; Hartmann, S. R. (Columbia Univ., New York). Contract DA-28-043 AMC-00099(E). Phys. Rev. Lett., 22: 867-70(Apr. 28, 1969).

Several resonances associated with the ^{40}K pure electric quadrupole interaction in $KClO_3$ were detected which allow the determination of the ^{40}K–^{39}K electric quadrupole moment ratio Q_{40}/Q_{39} (1.244 ± 0.002) and the asymmetry parameter η(0.621 ± 0.004). These resonances were detected with a new steady-state double-resonance technique which has excellent stability and high sensitivity. (auth)

23657 FAST NEUTRON ELASTIC AND INELASTIC SCATTERING FROM SILICON. Drake, D. M. (Los Alamos Scientific Lab., N. Mex.); Hopkins, J. C.; Young, C. S.; Conde, H.; Sattler, A. Nucl. Phys., A128: 209-18(1969).

The differential elastic and inelastic scattering cross sections of silicon were measured at incident neutron energies from 4.0 to 7.5 MeV. Neutrons and gamma rays produced in the inelastic scattering process were observed independently. The neutron cross sections were measured with a time-of-flight spectrometer relative to hydrogen. The gamma-ray spectra were measured with a NaI(Tl) spectrometer using time-of-flight techniques to eliminate the neutron background. The 1.78, 4.61, 4.97 and 6.27 MeV states were observed in both the neutron and gamma-ray studies. The two states at 6.876 and 6.885 MeV were observed but not resolved in the gamma-ray work. The experimental differential gamma-ray cross sections are compared with calculations based on Satchler's theory. (auth)

23658 DOPPLER-SHIFT LIFETIME MEASUREMENTS IN ^{20}Ne, ^{24}Mg, AND ^{28}Si. Anderson, John Herbert; Ritter, Rogers C. (Univ. of Virginia, Charlottesville). Nucl. Phys., A128: 305-24 (1969).

The (^{3}He,dγ) reaction has been used to study the γ-decay of levels in ^{20}Ne, ^{24}Mg and ^{28}Si. Lifetimes of three states in ^{20}Ne, five states in ^{24}Mg and eight states in ^{28}Si were measured using the Doppler-shift attenuation method with a 10 cm^3 or a 15 cm^3 Ge(Li) detector operated in coincidence with the outgoing deuterons. In addition, the energies of 43 transitions in these nuclei were determined; most of the energy assignments had smaller estimated errors than previously published values. The present results are used to assess rotational properties of these nuclei. In addition, the lifetime results in ^{28}Si are used as an aid to interpret Hartree–Fock calculations which have been published. (auth)

23659 THERMAL AND 14.4-MeV NEUTRON ACTIVATION CROSS SECTIONS OF ARGON. Ranakumar, N.; Karttunen, E.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Nucl. Phys., A128: 333-8(1969).

Thermal and 14.4-MeV neutron activation cross sections of argon were measured with argon quinol-clathrate powder as target material. The thermal neutron activation cross section of the ^{40}Ar(n,γ)^{41}Ar reaction was measured to be 510 ± 25 mb. The 14.4 ± 0.3-MeV neutron activation cross sections for the reactions ^{38}Ar (n,p)^{38}Cl, ^{40}Ar(n,p)^{40}Cl(1.4 min), ^{40}Ar(n,np + n, pn + n, d)^{39}Cl, and ^{40}Ar(n,α)^{37}S were measured to be 75 ± 20, 15.7 ± 2.0, 1.40 ± 0.15 and 10.5 ± 1.0 mb, respectively. These values are compared with prior measurements and with semi-empirical predictions of Levkovskii and of Gardner. (auth)

23660 MEASUREMENTS OF TOTAL CROSS SECTIONS FOR VERY SLOW NEUTRONS WITH VELOCITIES FROM 100 m/sec TO 5 m/sec. Steyerl, A. (Technische Hochschule, Munich). Phys. Lett., 29B: 33-5(Mar. 31, 1969).

Very cold neutrons from 60 μeV to 0.1 μeV were obtained through a vertical total-reflecting neutron guide tube. Total cross sections measured by time-of-flight technique for gold and aluminum were found to obey the $1/\nu$ law. (auth)

23661 ONE-NUCLEON TRANSFER REACTIONS ON DEFORMED NUCLEI. Schulz, H.; Wiebicke, H. J. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 29B: 18-20 (Mar. 31, 1969).

The one-nucleon transfer reaction on deformed nuclei is treated in terms of the DWBA, where, using the adiabatic approximation, rotational levels of the initial and final nuclei were taken into account. (auth)

23662 ENERGY SPECTRUM OF ^{20}Ne USING HARTREE–FOCK AND TAMM–DANCOFF WAVE FUNCTIONS. Tewari, S. N. (Univ. of California, Berkeley). Phys. Lett., 29B: 5-8 (Mar. 31, 1969).

The energy spectrum of the excited 0$^+$ band was calculated by projecting out good angular momentum states from a Tamm–Dancoff intrinsic state. The admixture between the projected Tamm–Dancoff and Hartree–Fock states was also calculated and its effect turns out to be negligible except for the 0$^+$ and 4$^+$ states. (auth)

23663 (^{3}He,α) REACTIONS ON THE CHROMIUM ISOTOPES. David, P. (Univ., Bonn); Duhm, H. H.; Bock, R.; Stock, R. Nucl. Phys., A128: 47-72(1969).

The reactions ^{50,52,53,54}Cr(^{3}He,α)^{49,51,52,53}Cr were studied at an incident energy of 18 MeV using a broad-range magnetic spectrograph as well as solid-state detectors. Angular distributions were obtained for all isotopes. The relative isotopic cross sections were accurately determined by measurements with a target of mixed Cr isotopes. Coulomb energy displacements are obtained from the observation of $f_{7/2}$, $d_{3/2}$ and $s_{1/2}$ and analogue states at excitation energies between 5 and 13 MeV. The spectroscopic factors from a DWBA analysis give information about the neutron configurations in the Cr isotopes which is discussed in the particle-hole excitation picture and in terms of the unified model. Centers of gravity for the $f_{7/2}$, $d_{3/2}$ and $s_{1/2}$ orbits are determined. The spectroscopic factors of the analogue states are obtained from solutions of the Lane equations for the bound states using a surface-type isospin potential. In a simplified analysis, the effects of the surface potential are simulated by varying the bound-state radii, keeping the depth of the potential constant for the $T_<$ and $T_>$ states. These procedures yield similar results, which are in agreement with the sum-rule predictions. The resulting radii suggest that the inner nucleons occupy a volume smaller than that corresponding to a potential radius $R = 1.25A^{1/3}$. (auth)

23664 STUDY OF THE ^{36}Ar(^{3}He,n)^{38}Ca REACTION. Shapiro, M. H.; Moss, C.; Denny, W. M. (California Inst. of Tech., Pasadena). Nucl. Phys., A128: 73-80(1969).

The energy levels of ^{38}Ca excited by the ^{36}Ar(^{3}He,n) reaction were investigated by neutron time-of-flight techniques. The previously unobserved ^{38}Ca analogues of the 3.377-MeV 0$^+$ and the 3.936-MeV 2$^+$ states in ^{38}Ar were seen at 3.06 MeV and 3.69 MeV, respectively. The vanishing of the Coulomb pairing energy appears to account for the lowering of the excitation energy of ^{38}Ca states compared to their ^{38}Ar analogues. (auth)

23665 ELASTIC SCATTERING OF 104-MeV ALPHA PARTICLES. Hauser, G. (Univ., Heidelberg); Loehken, R.; Rebel, H.; Schatz, G.; Schweimer, G. W.; Specht, J. Nucl. Phys., A128: 81-109(1969).

Differential cross sections were measured for elastic scattering of 104-MeV alpha particles on ^{6}Li, ^{9}Be, ^{12}C, ^{14}N, ^{16}O, ^{20}Ne, ^{40}Ar, ^{64}Ni, ^{90}Zr, ^{124}Sn, ^{208}Pb, and ^{209}Bi. All angular distributions show a pronounced diffraction pattern. For the lightest nuclei measured (^{6}Li to ^{16}O) the cross section exceeds the Rutherford cross section by a factor of up to 15 at angles around 45°. The cross section data were analyzed in terms of parametrized phase-shift functions using 9 free parameters and in terms of the spinless optical model using up to 7 free parameters. Good fits were obtained. A strong absorption was found for the heavy nuclei, $A \geqq 124$. For these nuclei, only the outermost region of the nuclear surface contributes to the scattering. A potential radius can not be extracted regardless of the pronounced diffraction pattern. The absorption is not so strong for the medium weight nuclei, $A = 20$ to 90. Information about the nuclear surface can be extracted from the differential cross section. The well-known phase ambiguity in the optical model was found for these nuclei. For the light nuclei ($A \leqq 16$) the inner region of the interaction potential contributes to the scattering. A repulsive core for small interaction distances explains the observed cross sections which indicate the nonlocal character of the true interaction. The phase shift analysis leads to good fits, but the phase shifts obtained differ significantly from those of the optical-model analysis. This indicates that the phase-shift analysis is ambiguous also. (auth)

23666 A STUDY OF PROTONS AND α PARTICLES FROM NEUTRON-INDUCED REACTIONS ON ^{40}Ca. Winterhalter, D.; Turk, M. (Inst. Ruder Boskovic, Zagreb). Fizika (Zagreb) 1: 137-46(1969).

Energy spectra of protons and alpha particles from 14.6-MeV neutron-induced reactions on ^{40}Ca were studied using the nuclear emulsion technique. Angular distributions of protons from the reactions ^{40}Ca(n,p)^{40}K and ^{40}Ca(n,np)^{39}K were measured. Experimental results were analyzed in the framework of statistical theory, and values for nuclear temperature for various reactions were deduced. (auth)

23667 EXTENSION OF THE OPTICAL DOUBLE RESONANCE TECHNIQUE TO SHORT-LIVED NUCLEI. Laulainen, Nels Stephen. Seattle, Univ. of Washington, 1968. 114p.

Thesis.

The optical double resonance technique has been used to determine the hyperfine structure of the $^3P_1$ state and the nuclear spins and moments of 38-min ^{63}Zn, 49-min ^{111m}Cd, and 55-min ^{105}Cd. These experiments represent the first successful attempt to study nuclei with half-lives $\gtrsim$ one hour with this technique. The shortest-lived isotope previously studied was 6.7-hour ^{107}Cd. The successful completion of this research conclusively demonstrates that the double resonance method is useful for nuclei with half-lives as short as the 38-min half-life of ^{63}Zn. These experiments were possible only through improved and more efficient isotope production and recovery techniques and through careful preselection of the operating fields and frequencies. On the basis of these experiments it should be possible to extend the optical double resonance method to nuclei with half-lives as short as 10 minutes. The isotopes were produced by the reactions ^{63}Cu(p,n)^{63}Zn, ^{110}Pd(α,3n)^{111m}Cd, and ^{104}Pd(α,3n)^{105}Cd on natural copper and palladium foils, respectively, at the University of Washington cyclotron. Typical activities of the samples were ~10Ci for ^{63}Zn (~1 × 10^{15} atoms), ~45mCi of ^{105}Cd (8 × 10^{12} atoms) and ~180mCi of ^{111m}Cd (3 × 10^{13} atoms). Due to these relatively high activities, special shielding precautions were necessary during the preparation of the absorption cell. Specially designed pieces of remote controlled apparatus were used in the isotope recovery. The cell preparation time was typically one hour. The samples available after the completion of a cell were typically $^1/_5$ to $^1/_{10}$ those given above. The initial operating fields and frequencies were chosen such that the individual Zeeman resonances were just resolved. This choice of operating conditions allows one to determine F and g_F and thus the nuclear spin I from the number of resonances, the known rf frequency, and the known fields. In addition the splittings between the resonances give preliminary values for the hyperfine intervals. The dipole moments are in accord with predictions of the shell model with configuration mixing. The values of Q_{105} and Q_{111m} are in fair agreement with predictions based on the known quadrupole moments of other cadmium isotopes, but are in poor agreement with the predictions of the shell model with configuration mixing. The value of Q_{63} is about twice as large as the predictions of the shell model with configuration mixing and about three times as large as the prediction based on the quadrupole moment of ^{67}Zn. (Disser. Abstr.)

23668 BETA-CIRCULARLY POLARIZED GAMMA ANGULAR CORRELATION STUDIES OF ^{48}V, ^{46}Sc, AND ^{56}Co. Meulenberg, Andrew Jr. Nashville, Vanderbilt Univ., 1968. 118p.

Thesis.

The $\beta-\gamma$ circular polarization correlation of the (698 keV, $4^+ \to 4^+, \beta^+) \to (1.31 + 0.99$ MeV, γ) cascade in ^{48}V, the (357 keV, $4^+ \to 4^+, \beta^-) \to (1.12 + 0.89$ MeV, γ) cascade in ^{46}Sc, and the (475 keV, $2^+ \to 2^+, \beta^+) \to (0.81$ MeV, γ) cascade in ^{56}Co were measured. The standard forward scattering technique for the detection of the circular polarization of the γ rays was used. A simple automatic angular correlation system was constructed to facilitate data acquisition. The energy selection of the β-rays was performed with an anthracene crystal in one ^{48}V experiment. A magnetic lens spectrometer was later used on this isotope as well as on the other isotopes. The use of this instrument has the following advantages: no scattering of electrons in air, negligible gamma-gamma coincidence background, improved energy selection of the beta rays and elimination of interfering 511 keV annihilation radiation in the β-detector in case of positron emitters. The measured anisotropy coefficients for ^{48}V, ^{46}Sc, and ^{56}Co are, respectively, -0.001 ± 0.024, 0.06 ± 0.03, -0.18 ± 0.04. From the measured values of the anisotropies, the Fermi to Gamow-Teller mixing ratios ($y = C_V M_V / C_A M_A$) were determined. The isotopic spin impurity coefficients $|\alpha|$ and the effective Coulomb matrix elements $|\langle H_c \rangle|$ were calculated for these isotopes: $|\alpha| \times 10^3 = 4.0 \pm 1.1$, 1.25 ± 1.25 and 0.4 ± 0.5; $|\langle H_c \rangle| = 28 \pm 8$, 10 ± 10, and 4.0 ± 5.5 keV, respectively. All these results are consistent with small or vanishing isotopic spin impurities. (Disser. Abstr.)

23669 ELECTRON AND PHOTON EXCITATION OF NUCLEAR ISOMERS. Brownson, John Stewart. Boston, Boston Univ., 1968. 153p.

Thesis.

An investigation was made of excited nuclear states whose decay populates the long-lived isomeric states of ^{87}Sr, ^{195}Pt, and ^{199}Hg. The methods of Chertok and Booth were improved in detail and extended to these new and more difficult cases. A major advance has resulted from replacing the first Born electron scattering theory they employed with an exact partial wave theory. States were observed at 1.22 MeV, 1.88 MeV, and 2.66 MeV in ^{87}Sr; at 1.13 MeV, 1.30 MeV, and 1.97 MeV in ^{195}Pt; and at 1.21 MeV, 1.39 MeV, 1.49 MeV, and 1.61 MeV in ^{199}Hg. Except for the 1.22 MeV state and possibly the 2.66 MeV state of ^{87}Sr, all of these are new states. The ratios between the integrated photon excitation cross sections and the inelastic electron scattering cross sections were measured and were used with the partial wave electron scattering theory to infer the dominant multipolarity of the $I_0 \to I$ transition for seven of the states: transitions to the 1.22 MeV, 1.88 MeV, 1.13 MeV, 1.30 MeV, and 1.97 MeV states were determined to be E2 and those to the 1.49 MeV and 1.61 MeV states to be M1. Tentative spin and parity assignments for the states were made. It is noted that in these excitation function experiments, the isomeric state serves as a detector, permitting counting with the electron accelerator shut off and thus the severe background problems associated with conventional resonance scattering or electron scattering experiments are avoided. The excitation function technique is particularly sensitive to M1 and E2 transitions. Partial widths for higher multipoles would be too small to detect while E0 and E1 transitions are possible, but unlikely. Resonance absorption measurements were made for all states except the 1.21 MeV and 1.39 MeV states. Partial widths of 33 ± 17 and 13 ± 6 E2 single particle units were obtained for the 2.66 MeV and 1.61 MeV states, respectively, and useful upper limits set for the other states. Low isotopic abundance limited the sensitivity of the resonance absorption measurements. Direct bremsstrahlung flux measurements were made permitting more accurate determination of photon excitation cross sections. A substantial advance has been made beyond the earlier work in that experimental results agree with the partial wave theory to a probable error of about 25% while the earlier Fermi corrected Born approximation calculations differ from experiment by a factor of 2 or 3. The partial wave theory employed was that of Griffy, Biedenharn, Reynolds, Onley, and Wright and was utilized in the form of a computer program known as GBROW. The results constitute the first test of the GBROW theory at energies near threshold. All earlier work was for energies 50 to 200 MeV above threshold. Earlier use of GBROW was concerned with the differential cross section for inelastic electron scattering and the reduced transition probability was usually treated as a free constant of proportionality. (Disser. Abstr.)

23670 LOW-ENERGY EXCITED STATES OF ^{54}Mn. Balanda, A.; Gasior, M.; Lizurej, H. I.; Niewodniczanski, H. (Jagellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow). Acta Phys. Pol., 35: 295-300(Feb. 1969).

The low-energy excited states of ^{54}Mn were investigated by means of the reaction ^{54}Cr(p,n)^{54}Mn at a proton energy of 2.7 MeV. The energy of the first two excited states, 54.3 ± 0.5 and 156.9 ± 1 keV, respectively, were determined from the internal conversion electron spectrum. The ratio of internal conversion coefficients, $\alpha_K/(\alpha_L+\alpha_M)$, for the 54.3 keV transition was found to be 7.1 ± 1. (auth)

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Refer also to abstracts 21755, 23625, 23639, 23660, 23661, 23665, 23667, 23669, 23746, 23752, and 23910.

23671 (CEA-N-989) CRITICAL EXAMINATION OF $\alpha = \sigma_C/\sigma_F$ VALUES FOR ^{239}Pu ABOVE 1 keV AND EXPERIMENTS FOR IMPROVING THESE VALUES. Barre, Jean-Yves; l'Heriteau, Jean-Pierre; Ribon, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1968. 74p. (EANDC(EUR)-111). Dep.

A critical examination was made of previously reported values of α for ^{239}Pu above 1 keV, and experiments were performed to improve the data on these values. The microscopic measurements made (irradiation, determination beginning with σ_t and σ_f, direct measurement of α, and measurement of η) are described in detail, and the results obtained are reported. Three methods (ratio of danger coefficients, K_∞ unity, and "Barraka") were used to measure macroscopically the values of the $\bar{\alpha}$ parameter of ^{239}Pu on critical assemblies. The effect of possible variations of the α parameter (multiplication coefficient and breeding rate) on the parameters of the fast neutron reactor Phenix was studied. In particular, the Phenix parameters obtained with the α values obtained in this study are examined. The experiments which can improve the knowledge of α are discussed. (tr-auth)

23672 (JINR-P6-4247) INVESTIGATION OF THE ^{144}Gd AND ^{145}Gd DECAY; ON THE PECULIARITIES OF THE QUASIPARTICLE $2d_{3/2}$ AND $3s_{1/2}$ LEVELS. Arl't, R.; Baiev, G.; Muziol, G.; Peker, L. K.; Pfrepper, G.; Shtrusnyi, Kh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 25p. (In Russian). Dep.

A new isotope ^{144}Gd with a half-life of 4.9 ± 0.4 min was found. The endpoint energy of its β^+ spectrum is 3300 ± 400 keV. β^+ and γ spectra of the ^{145}Gd decay were studied, on the basis of which the decay scheme of ^{145}Gd is constructed. This scheme is discussed in the framework of model representations. The location of the quasiparticle $2d_{3/2}$ and $3s_{1/2}$ levels is considered separately. β^+ and γ coincidences were investigated to verify the decay scheme. (auth)

23673 (JINR-P6-4276) THREE-QUASIPARTICLE ISOMER IN ^{143}Sm. Neubert, W.; Alexander, K.; Rotter, H.; Chojnacki, S.; Droste, Ch. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 30p. (In Russian). Dep.

In the reactions ^{126}Te(^{22}Ne,5n)^{143}Sm, ^{128}Te(^{22}Ne,7n)^{143}Sm, and ^{130}Te(^{20}Ne,7n)^{143}Sm a highly excited isomeric state with a half-life of 35 ± 8 ms was found. The atomic number was assigned by means of the conversion electron spectrum from the measured difference of K and L electron binding energies. The mass number follows from excitation function measurements. The following γ rays were observed: 51 keV, 75 keV(M1), 180 keV(E1), 209 keV(E3-isomeric transition), 1574 keV, 1703 keV, and 1829 keV. The γ-ray spectrum and the isomeric cross-section ratios measured for the reactions ^{124}Te(^{22}Ne,3n), ^{126}Te(^{22}Ne,5n), ^{128}Te(^{22}Ne,7n), and ^{130}Te(^{20}Ne,7n) are in agreement with the fact that the 35-ms isomer decays to the first isomeric level in ^{143}Sm. The 35-ms isomeric state has an excitation energy of 2793 keV. Several three-quasiparticle configurations which could explain the existence of the isomeric state are discussed. (auth)

23674 (KFKI-3/1969) ANOMALOUS HYPERFINE FIELD AT RECOILED Rh NUCLEI OF LOW ENERGY IN $Fe_{51.5}-Rh_{48.5}$ ALLOY. Varga, L.; Demeter, I.; Keszthelyi, L.; Pocs, L.;

Szoekefalvi-Nagy, Z. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1969]. 7p. Dep.

The rotation angles for the 298- and 362-keV states of ^{103}Rh were measured after Coulomb excitation with 2.5-MeV protons in Fe–Rh alloy in an attempt to determine the g-factors of the two states. The results were interpreted by considering the existence of a transient field at such low energies. (D.C.W.)

23675 (ORNL-TM-2353) NEUTRON FISSION AND CAPTURE CROSS-SECTION MEASUREMENTS FOR ^{233}U IN THE ENERGY REGION 0.02 TO 1 eV. Weston, L. W.; Gwin, R.; de Saussure, G.; Ingle, R. W.; Todd, J. H.; Craven, C. W. (Oak Ridge National Lab., Tenn.); Hockenbury, R. W.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Feb. 1, 1969. 26p. Dep. CFSTI.

The relative neutron capture and fission cross section in the neutron energy range 0.02 to 1.0 eV were measured simultaneously. The data are normalized by means of the previously reported total cross section. The technique used was passing a pulsed neutron beam through a ^{233}U fission chamber placed at the center of a large liquid scintillator. The prompt neutron capture gamma rays were detected only in the liquid scintillator, whereas a fission event was characterized by coincident signals from the liquid scintillator and fission chamber. This technique provides a new method of obtaining eta in this neutron energy range which is not subject to the same type errors as a direct measurement. Comparisons with previously published data are given. (auth)

23676 (RLO-1388-93) GAMMA TRANSITIONS FROM ISOBARIC ANALOGUE RESONANCES IN THE ^{92}Mo(p,γ)^{93}Tc REACTION. Ejiri, H.; Ferguson, S. M.; Halpern, I.; Heffner, R. (Washington Univ., Seattle. Dept. of Physics). (1968). 11p. Dep. CFSTI.

The ^{92}Mo(p,γ) reactions showed strong gamma transitions from an isobaric analogue state (IAS) of a single neutron state to low-lying single proton states. No measurable gamma transitions were observed to lower states from an IAS of a collective state. (auth)

23677 (UCRL-18632) CALCULATED FRACTIONAL INDEPENDENT YIELDS OF PRODUCTS FORMED IN THE SPONTANEOUS FISSION OF ^{252}Cf. Watson, R. L.; Wilhelmy, J. B. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 1969. Contract W-7405-eng-48. 40p. Dep. CFSTI.

Element yields for Z = 36 to 62 were calculated together with fractional independent yields and absolute fission yields for the elements comprising each mass chain. The charge distribution for direct formation products was assumed to be Gaussian. (D.C.W.)

23678 THE DECAY OF ^{97}Ru. Graeffe, G. (Technical Univ. of Helsinki). Nucl. Phys., A127: 65-70(1969).

The decay of ^{97}Ru to the levels in ^{97}Tc was studied with the use of semiconductor detectors, a NaI(Tl) crystal and coincidence equipment. Gamma-ray energies and relative gamma-ray intensities were determined as well as conversion coefficients for some transitions. Excited states were found at 215, 324, 784, and 976 keV. The level structure was compared to current theoretical calculations. (auth)

23679 VIBRATIONAL STATES OF ^{207}Tl. Hansen, Ole (Univ. of Copenhagen); Nathan, O.; Chapman, R.; Hinds, S. Nucl. Phys., A127: 71-80(1969).

The reaction ^{205}Tl(t,p)^{207}Tl was studied at E_t = 13 MeV by means of a magnetic multi-angle spectrograph. A total of 15 excited states of ^{207}Tl were identified below E_x = 4.6 MeV. Transitions with L = 0 were found to the ground state (110%) and to states at 4.35 MeV (51%) and 4.54 MeV (17%). The known $d_{3/2}$ and $d_{5/2}$ hole states were excited in the ratio 1 : 0.4. An attempt was made to interpret the higher lying states in terms of vibrational excitations, where the s- and d-hole proton states are coupled to the 0^+ (pairing vibrational), 3^- and 5^- vibrations of the ^{208}Pb core. (auth)

23680 INELASTIC NEUTRON SCATTERING AND FISSION OF ^{232}Th NEAR THE FISSION THRESHOLD. Holmberg, M.; Stroemberg, L. G.; Wallin, L. (Research Inst. of National Defence, Stockholm). Nucl. Phys., A127: 149-60(1969).

Excitation functions for inelastic neutron scattering from the 800-keV, the 1100-keV, and the 1.45- to 1.60-MeV levels in ^{232}Th were measured in the energy range 1.0 to 2.2 MeV. The experimental results show that the structure in the fission cross section of ^{232}Th near the fission threshold can not be adequately interpreted in terms of competition between fission and neutron emission. Calculations with an extension of a fission model originally proposed by Lynn point to the importance of the detailed structure of the potential surface for the deforming nucleus as a source for structure in the fission cross section. (auth)

23681 INELASTIC PROTON SCATTERING FROM ^{91}Zr AT 18.7 MeV. Blok, H. P. (Vrije Univ., Amsterdam); Thijs, G. D.; Kraushaar, J. J.; Stautberg, M. M. Nucl. Phys., A127: 188-208 (1969).

The level structure of ^{91}Zr was investigated by inelastic proton scattering at 18.7 MeV. Angular distributions were obtained for the excitation of 19 levels in ^{91}Zr. The results for the low-lying states, seen strongly in the ^{90}Zr(d,p) reaction, were compared to distorted wave calculations using shell model form factors for the excitation of the odd neutron beyond the closed shell of 50. The resulting depth of the interaction potential indicated a relatively strong core excitation admixture for these states. Calculations using more complicated wave functions gave better results especially if core polarization effects were included. At higher excitation energies the six states resulting from the coupling of the $d_{5/2}$ neutron to the 3^- excited state of ^{90}Zr were observed. The cross sections were consistent with the predictions of the weak coupling model. (auth)

23682 A NUMBER-CONSERVING CALCULATION OF THE NUCLEAR SPECTRA OF THE ODD-MASS ISOTOPES OF Pb, Tl, AND Hg. Lo, Iudice N. (Univ., Rome. CSN, Cascaccia, Rome); Prosperi, D.; Salusti, E. Nucl. Phys., A127: 221-33(1969).

A calculation was performed for the low-energy spectra of Pb, Tl, and Hg odd-mass isotopes. The method is a simplified version of a theory first suggested to treat pairing correlations in nuclei without violating particle number conservation (Jean–Klein theory). The residual nucleon-nucleon interaction is a (pairing +P_2) potential. The results were compared with those obtained by other models and with the experimental data. (auth)

23683 ^{122}Sb ISOMERIC-STATE FORMATION BY (γ,n) REACTION. Goldman, I. D.; Matsushigue, T.; Moreira, J. R.; Silva, E. (Univ., Sao Paulo, Brazil). Nuovo Cim., Lett., 1: 462-4(Mar. 21, 1969).

The formation of the ^{122}Sb isomeric state by the photonuclear reaction was investigated from threshold to 19 MeV by observing the residual activity from natural Sb samples irradiated in a bremsstrahlung beam. The cross section for formation of the isomeric state was calculated by the Katz–Cameron method. The ratio of the cross sections for the reaction to the ground state and to the isomeric state was obtained. The ratio of the effective inertial moment to the rigid-body inertial moment was calculated. The low value of the inertial moment in relation to the rigid-body moment indicates good sphericity for this nucleus. (D.C.W.)

23684 RESONANCE LEVELS OF SOME RARE ISOTOPES OF LANTHANIDES. Vertebnyi, V. P.; Kalchenko, A. I.; Pasechnik, M. V.; Pisanko, Zh. I.; Rudyshin, V. K. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 2085-6(Dec. 1968). (In Russian).

Resonances in ^{156}Dy, ^{158}Dy, ^{160}Dy, ^{152}Gd, and ^{154}Gd were investigated in the neutron energy range from 0.5 to 1000 eV in order to study the variation of level density with neutron number at constant Z. Strength functions were determined. (R.V.J.)

23685 E0 TRANSITIONS IN ^{152}Sm AND ^{152}Gd. Mukherjee, P.; Mukherjee, I. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Lett., 28B: 592-3(Mar. 3, 1969).

The E0/E2 intensity ratios were determined for four transitions between the beta- and gamma-vibrational band and the ground-state rotational band in ^{152}Sm. Two new E0 transitions were also found in ^{152}Gd. (auth)

23686 GAMMA SPECTRA DURING ABSORPTION OF THERMAL NEUTRONS AND NEUTRONS WITH 4.41-eV ENERGY BY ^{187}Re NUCLEUS. Vertebnyi, V. P.; Gnidak, N. L.; Pavlenko, E. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 2082(Dec. 1968). (In Russian).

The gamma spectra resulting from the absorption of thermal and 4.41-eV neutrons by ^{187}Re were measured. An attempt was made to determine the difference between γ spectra arising from positive and negative states. (R.V.J.)

23687 VARIATIONS IN γ-RAY SPECTRA PRODUCED IN CAPTURE OF RESONANCE NEUTRONS BY ^{167}Er. Pavlenko, E. A.; Gnidak, N. L. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 2083-4(Dec. 1968). (In Russian).

The behavior of the high-energy portion of the γ spectrum resulting from resonance capture of 0.3- to 30-eV neutrons by ^{167}Er was investigated using a single-crystal NaI(Tl) spectrometer. (R.V.J.)

23688 DIFFRACTION OF RESONANT γ RADIATION IN BRAGG SCATTERING BY NUCLEI AND ELECTRONS IN PERFECT SINGLE CRYSTALS OF TIN. Voitovetskii, V. K.; Korsunskii, I. L.;

Pazhin, Yu. F. JETP Lett. (USSR) (Engl. Transl.), 8: 343-5 (Nov. 20, 1968).

Translated from Zh. Eksp. Teoret. Fiz., Pis'ma Redaktsiyu, 8: 563-5(Nov. 20, 1968).

The diffraction of γ radiation in Bragg reflection from perfect single crystals of tin was investigated using a two-crystal spectrometer. The agreement with calculations based on dynamic theory confirms that the Bragg reflection from a thick ideal crystal is determined by the dynamic character of the scattering. (J.W.R.)

23689 CONCERNING THE CORRELATION OF γ QUANTA IN THE X-RAY BAND. Labushkin, V. G., Nikolaev, E. P. JETP Lett. (USSR) (Engl. Transl.), 8: 341-3(Nov. 20, 1968).

Translated from Zh. Eksp. Teoret. Fiz., Pis'ma Redaktsiyu, 8: 560-2(Nov. 20, 1968).

The 23.8-keV γ ray from ^{119}Sn was measured with a NaI(Tl) crystal. An additional peak due to random coincidences within the limits of resolving time appeared in the spectra. The intensity of the source was decreased until the random coincidences were negligible thus eliminating the additional peak and casting doubt on the correlation effect reported earlier for γ spectra from ^{119}Sn. (J.W.R.)

23690 M1 TRANSITIONS FOLLOWING THE SLOW-NEUTRON CAPTURE IN ^{115}In. Fubini, A.; Giannini, M.; Prosperi, D.; Rado, V. (CNEN, Rome). Nuovo Cim., Lett., 1: 467-9(Mar. 21, 1969).

The gamma spectrum resulting from thermal neutron capture by ^{115}In was measured using a Ge(Li) detector. Gamma energies and intensities were determined. Six M1 transitions to levels at 127, 222, 274, 312, 653, and 913 keV were identified. E1 transitions to the 366-, 460-, 556-, 729-, 889-, 951-, and 1007-keV levels were also observed. Spin-parity assignments were made for several levels in ^{116}In. (D.C.W.)

23691 MAGNETIC PROPERTIES OF THE [624]$^9/_2$ ROTATIONAL BAND IN ^{177}Hf. Huebel, H.; Guenther, C.; Krien, K.; Toschinski, H.; Speidel, K.-H.; Klemme, B.; Kumbartzki, G.; Gidefeldt, L.; Bodenstedt, E. (Univ., Bonn). Nucl. Phys., A127: 609-21(1969).

The E2/M1 mixing ratios of six $\Delta I = 1$ transitions in the [624]$^9/_2$ band in ^{177}Hf were determined from γ-γ angular correlation and L-subshell conversion measurements. The magnetic moment of the ground state of this band was measured using the large magnetic hyperfine field of Hf in iron. The mixing ratios can be described by a constant value of the collective model quantity $(g_K - g_R)/Q_0$ within an accuracy of 5%. The deduced values $g_K = -0.231 \pm 0.034$ and $g_R = 0.154 \pm 0.026$ are compared with theoretical predictions. (auth)

23692 DECAY OF THE ^{124}Sb ISOMERS TO LEVELS OF ^{124}Te. Meyer, R. A. (Riso Research Establishment, Denmark. Univ. of California, Livermore); Walters, W. B.; Ragaini, R. C. Contract AT(30-1)-905. Nucl. Phys., A127: 595-608(1969).

The levels of ^{124}Te were investigated by studying the γ rays emitted following the decay of the 60-d and 1.5-min isomers of ^{124}Sb. Using a Compton-suppressed Ge(Li) γ-ray detector and NaI(Tl)−Ge(Li) and Ge(Li)−Ge(Li) coincidence systems, 65 γ rays were assigned to the 22 proposed levels of ^{124}Te populated in the decay of the 60-d isomer. The spin and parity of the 1.5-min isomer of ^{124}Sb are discussed and also the nature of the proposed second 3^- level at 2693.87 keV. (auth)

23693 THE log ft VALUES OF ALLOWED DECAYS FROM ^{114}In. Coffman, F. E.; Hamilton, J. H. (Vanderbilt Univ., Nashville). Nucl. Phys., A127: 586-94(1969).

Singles and coincidence measurements were carried out on the decay ^{114m}In−^{114}In with Ge(Li) detectors. The following transitions in keV were observed (intensities in parentheses): 558.04 ± 0.16 (102 ± 4), 575.74 ± 0.12 (0.115 ± 0.010), 725.21 ± 0.10(100) and 747.75 ± 0.15 (0.089 ± 0.009) in ^{114}Cd and 1299.98 ± 0.12(4.10 ± 0.25) in ^{114}Sn. Previous unreported log ft values were derived for decays of 1^+ ^{114}In to the 1133.8 keV (0^+), 1208 keV (2^+), 1305.8 keV (0^+), and 1363 keV (2^+) levels in ^{114}Cd as 5.5, > 6.5, 4.8, and > 5.7, respectively. (auth)

23694 TERNARY FISSION PRODUCED IN Au, Bi, Th, AND U WITH Ar IONS. Perelygin, V. P. (Joint Inst. for Nuclear Research, Dubna, USSR); Shadieva, N. H.; Tretyakova, S. P.; Boos, A. H.; Brandt, R. Nucl. Phys., A127: 577-85(1969).

Ternary fission of Au, Bi, Th, and U induced with 230 to 380 MeV Ar ions is studied using a 2π geometry. Thin layers of heavy elements made by evaporation on the surface of mica detectors are irradiated with heavy ions. The fission fragment tracks are revealed separately after a heat treatment followed by etching. The observed ratio of ternary fission to binary fission increases with the energy of Ar ions and with Z^2/A of the compound nuclei. Angular distributions and the length of the fission tracks are reported. (auth)

23695 MEASUREMENTS OF α_K FOR THE 84.3-keV TRANSITION IN ^{170}Yb AND THE 80.6-keV TRANSITION IN ^{166}Er. Nelson, G. C.; Hatch, E. N. (Ames Lab., Iowa). Nucl. Phys., A127: 560-6(1969). (IS−1730).

The K-shell internal conversion coefficients for the 84.3-keV $2^+ \rightarrow 0^+$ transition in ^{170}Yb and the 80.6-keV $2^+ \rightarrow 0^+$ transition in ^{166}Er were measured to 3% by the K x-ray/γ ratio method with a NaI(Tl) crystal, a bent-crystal spectrometer and a least-squares fitting technique. The experimental conversion coefficients of $\alpha_K = 1.43 \pm 0.04$ and $\alpha_K = 1.72 \pm 0.6$ for ^{170}Yb and ^{166}Er, respectively, agree with the presently available theoretical values for pure E2 transitions. In the case of ^{170}Yb, it was also possible to determine the intensity of the K-capture branch to ^{170}Er. The present value of 0.19 ± 0.04% agrees with the previous determination of 0.15 ± 0.05% by Day. (auth)

23696 NUCLEAR MATRIX ELEMENTS IN THE 2.14-MeV BETA GROUP IN ^{139}Ba. Agarwal, Y. K.; Baba, C. V. K.; Mitra, S. K. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A127: 652-60(1969).

The spectral shape and beta-gamma directional correlation of the 2.14-MeV ($^7/_2{}^- \rightarrow {}^5/_2{}^+$) beta-group in the decay of ^{139}Ba were studied. The spectral shape measured in coincidence with the 166-keV γ ray shows a large deviation from a statistical shape. The beta-gamma directional correlation coefficient A_2 varies from 0.01 to 0.06 in the energy region 0.5 to 2.0 MeV. The ratios of relevant nuclear matrix elements were obtained from these two measurements. The absolute values of the matrix elements involved were calculated from the known ft value. The matrix element $\int$ ir was found to be 3.9×10^{-3} (in natural units) as compared to a value of 7.1×10^{-3} calculated on the basis of the single-particle shell model. The structure of the $^5/_2{}^+$ state in ^{139}La is discussed on the basis of these results. (auth)

23697 PARTICLE PARAMETERS FOR CONVERSION ELECTRONS IN ^{152}Sm, ^{152}Gd, AND ^{160}Dy. Agarwal, Y. K.; Baba, C. V. K.; Mukhopadhyay, N. C. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A127: 661-8(1969).

The internal conversion-electron particle parameters for several low-lying E2 transitions in ^{152}Sm, ^{152}Gd, and ^{160}Dy were determined by making e^--γ and γ-γ directional correlation measurements on the same source. In several of these cases both b_2(E2, K) and b_4(E2, K) were measured. The results are: (i) 122 keV transition in ^{152}Sm: $b_2(K) = 1.82 \pm 0.05$, $b_4(K) = -1.06 \pm 0.14$ and $b_2(L) = 1.30 \pm 0.07$, (ii) 344 keV transition in ^{152}Gd: $b_2(K) = 1.62 \pm 0.13$, (iii) 87 keV transition in ^{160}Dy: $b_2(K) = 1.90 \pm 0.07$, $b_4(K) = -1.25 \pm 0.18$ and $b_2(L) = 1.37 \pm 0.18$. The measured values of $b_4(K)$ were also used in determining $b_2(K)$. In all the cases measured, no deviations from the theoretical values were observed within the experimental errors. (auth)

23698 K-SHELL CONVERSION COEFFICIENT OF THE 40.58-keV TRANSITION IN ^{99}Mo DECAY. Ranakumar, N. (Georgia Inst. of Tech., Atlanta); Fink, R. W.; Rao, P. Venugopala. Nucl. Phys., A127: 683-6(1969).

The multipolarity of the 40.584-keV transition between the 181.095- and 140.511-keV levels in ^{99}Tc is established as M1 by a precision measurement of α_K (3.2 ± 0.2) with a coincidence technique. (auth)

23699 HALF-LIFE OF THE 2^- STATE AT 990 keV IN ^{234}U. Bengtson, B.; Nielsen, H. L. (Univ. of Aarhus, Denmark). Nucl. Phys., A127: 679-82(1969).

The half-life of the $KI^\pi = 22^-$ state at 990 keV in ^{234}U was measured by means of delayed-coincidence techniques to be 0.76 ± 0.04 ns. The resulting squared transition matrix element for the 946 keV E1 radiation from this state to the ground-state band was found to be $(0.19 \pm 0.05)e^2 \times 10^{-32}$ cm^2. This value is in good agreement with previous estimates of the magnitude of the corresponding quantity for the $I^\pi = 4^-$ and 6^- members of the same rotational band. (auth)

23700 CROSS SECTIONS FOR THE PHOTOFISSION OF ^{232}Th INDUCED BY MONOENERGETIC GAMMA RAYS OF 12 DIFFERENT ENERGIES. Manfredini, A. (Istituto Nazionale di Fisica Nucleare, Messina, Italy. Univ., Messina, Italy); Fiore, L.; Ramorino, C.; De Carvalho, H. G.; Woelfli, W. Nucl. Phys., A127: 687-92(1969).

Thorium-loaded nuclear emulsions were exposed to monoenergetic γ-rays obtained from (n,γ) reactions on the following elements: S, Dy, Y, Ca, Ti, Be, Mn, Pb, Fe, Al, Cu, and Ni. The photofission cross section of ^{232}Th was measured at 12 energies in the range 5.4 to 9 MeV. For the same energies, the ratios of the ^{232}Th cross section with respect to ^{238}U are also given. (auth)

23701 LI AND Be NUCLEI EMITTED DURING THE THERMAL NEUTRON FISSION OF ^{235}U. Blocki, J.; Chwaszczewska, J.; Dakowski, M.; Krogulski, T.; Piasecki, E.; Sowinski, M.; Stegner, A.; Tys, J. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Phys., A127: 495-502(1969).

The energy spectra and relative yields of lithium and beryllium nuclei emitted during the thermal neutron fission of ^{235}U were investigated using a two-counter telescope with a proportional counter as the ΔE detector. The experimental results are compared to model calculations. (auth)

23702 ACCURATE GAMMA-RAY ENERGY MEASUREMENTS IN THE DECAYS OF ^{207}Bi, ^{208}Tl, AND ^{212}Bi. Brahmavar, S. M.; Hamilton, J. H. (Vanderbilt Univ., Nashville). Nucl. Instrum. Methods, 69: 353-4(Apr. 1969).

The gamma-ray energies of the 1770.06 ± 0.07-keV transition in ^{207}Bi and the 727.08 ± 0.07-keV transition in ^{212}Bi along with six additional transitions in the decay chain of ^{228}Th were measured more carefully for use as energy calibration standards. (auth)

23703 PRODUCTION OF ^{32}P IN NUCLEAR REACTIONS INDUCED BY HEAVY IONS. Lagarde, Monique; Simonoff, Gabriel (Laboratoire de Chimie Nucleaire, Bordeaux. CNRS, Gradignan, France). Compt. Rend., Ser. A, B, 268: 646-9 (Feb. 24, 1969). (In French).

A study is made of the production of ^{32}P in reactions induced by the ions ^{16}O and ^{20}Ne on targets of nickel, silver, and gold. In every case the production mechanism is consistent with the fission. (tr-auth)

23704 NUCLEAR RESEARCH WITH HEAVY ION ACCELERATORS. Kusch, Wlodzimierz (Inst. for Nuclear Research, Warsaw). Postepy Fiz., 82: 667-87(1968). (In Polish).

Actual results of transuranium elements synthesis with heavy ion accelerators are reviewed, as well as investigations of delayed proton emission and transuranium-element fission from isomeric states. (auth)

23705 DETERMINATION OF THE FISSION-NEUTRON CROSS-SECTION FOR THE ^{90}Zr (n,p)^{90}Y REACTION. Fischer, W. (Fachbereich Kernenergetik, Berlin). Isotopenpraxis, 5: 17-19 (Jan. 1969). (In German).

The fission neutron cross section of the ^{90}Zr(n,p)^{90}Y reaction in the Rossendorf Research Reactor was found to be $\sigma_{int} = 0.50 \pm 0.068 \times 10^{-27}$ cm^2, normalized to the flux above the threshold of the reactions S = 1.46 MeV. The carrier-free and quantitative isolation of ^{90}Y from the target was achieved by using ion exchangers. (auth)

23706 NUCLEAR ISOMERS WITH HALF LIVES IN THE 20-μsec TO 15-msec RANGE. Iordachescu, A.; Pascovici, G.; Plostinaru, D. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 911-12(1968).

Numerous short-lived isomers were observed in bombardment of thick targets of natural elements with 17.2- to 20-MeV α particles and 7.6- to 12-MeV protons. Gamma spectra were recorded between irradiation pulses at eight successive time intervals using an NaI(Tl) detector. Half-life measurements were also made. (D.C.W.)

23707 NUCLEAR ISOMERS WITH HALF LIVES IN THE 2- TO 3-μsec RANGE EXCITED BY PULSED-BEAM PROTON IRRADIATIONS. Ivanov, E. A.; Iordachescu, A.; Pascovici, G. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 879-85 (1968).

Twelve isomers with half-lives between 2 and 30 μsec were excited by irradiating targets of natural isotopic abundance with a pulsed proton beam. Previously unreported isomeric decays were detected from the following targets (half-lives and gamma energies): Cd (2 μsec, 203 and 278 keV); Sn (16 μsec, 51 keV); and Er (5.2 μsec, 145 keV). (D.C.W.)

23708 LEVEL SCHEME OF ^{220}Fr. Leang, Chin Fan; Walen, Robert; Bastin, Genevieve (CNRS, Orsay, France). Compt. Rend., Ser. A, B, 268: 434-6(Feb. 3, 1969). (In French).

The combined direct and multidimensional spectrographic data obtained to date on the decay ^{224}Ac $\rightarrow$ ^{220}Fr lead to a scheme in which several levels are not measurably fed by α emission. (tr-auth)

23709 STUDY OF THE DECAY ^{117}Cd $\rightarrow$ ^{117}In. Moret, Roger (Institut des Sciences Nucleaires, Grenoble, France). Compt. Rend., Ser. A, B, 268: 430-3(Feb. 3, 1969). (In French).

The lifetimes for the decay of the ground state $(\frac{1}{2}^+)$ (^{117g}Cd : T = 160 ± 10 min) and of the 133-keV isomeric state $(\frac{11}{2}^-)$ (^{117m}Cd : T = 210 ± 10 min) of ^{117}Cd were measured; certain characteristics of the β-decay branches of the two levels were determined. (tr-auth)

23710 COULOMB FRAGMENTATION OF MOLECULES FOLLOWING BETA EMISSION. Berman, M.; Beard, G. B. (Wayne State Univ., Detroit). Phys. Rev. Lett., 22: 753-5 (Apr. 14, 1969).

Nuclear resonance-fluorescence scattering from 364-, 637-, and 723-keV levels of ^{131}Xe was observed. The results obtained with a gaseous source of ^{131}I were different from those obtained using a gaseous source of CH$_3$^{131}I. The significant differences are ascribed to the effects of Coulomb fragmentation of the (IXe^{131})$^+$ molecular ion formed following the beta decay of ^{131}I. (auth)

23711 ISOMER SHIFT OF THE 123-keV GAMMA RAYS OF ^{154}Gd. Rehm, K. E.; Henning, W.; Kienle, P. (Technische Hochschule, Munich). Phys. Rev. Lett., 22: 790-2(Apr. 14, 1969).

Isomer shifts of the $2^+ \rightarrow 0^+$ rotational transition in ^{154}Gd were determined in Moessbauer measurements. From comparison with isomer shifts in ^{156}Gd and ^{158}Gd, the ratios $\Delta\langle r^2\rangle_{154}/\Delta\langle r^2\rangle_{156} = +7.3 \pm 1.9$ and $\Delta\langle r^2\rangle_{154}/\Delta\langle r^2\rangle_{158} = +30 \pm 10$ are deduced. These ratios imply a considerable increase in rigidity for deformed nuclei above neutron number N = 90. The existing theoretical values are discussed. (auth)

23712 AN ANOMALY IN THE ANALYZING POWER OF ^{90}Zr(d,p$_0$)^{91}Zr. Clausnitzer, G.; Graw, G.; Moore, C. Fred; Wienhard, K. (Univ. of Erlangen, Ger.). Phys. Rev. Lett., 22: 793-4(Apr. 14, 1969).

The reaction ^{90}Zr(d,p$_0$)^{91}Zr was studied using a vector-polarized deuteron beam. Excitation functions were measured in the region near the (d,n) threshold to the analog in ^{91}Nb of the ^{91}Zr ground state. The analyzing power shows an abrupt change in behavior at this threshold and complements the earlier observation of a cusp at this energy in the differential cross section. (auth)

23713 SHAPE OF THE β SPECTRA FOR TRANSITIONS $1^- \rightarrow 0^+$ IN THE DECAY OF ^{170}Tm, ^{186}Re, AND ^{188}Re. Andre, Stephane; Liaud, Pierre (Institut des Sciences Nucleaires, Grenoble, France. CEDEX, Grenoble, France). Compt. Rend., Ser. A, B, 268: 270-3(Jan. 20, 1969). (In French).

The shape factors $n(p)/p^2(W_\infty - W)^2F_0$, where p is the electron momentum and W_∞ is the endpoint energy, were determined as a function of electron momentum for the $1^- \rightarrow O^+$ transitions in ^{186}Re, ^{188}Re, and ^{170}Tm. The shape factors of the three isotopes are of the same type, increasing with energy. The deviations from the statistical shape are of the same order in all three cases. (D.C.W.)

23714 UNIFIED-MODEL CALCULATIONS FOR ODD-MASS Cs AND La ISOTOPES. Freed, N.; Miles, W. (Pennsylvania State Univ., University Park). Nuovo Cim., 60B: 301-10(Apr. 11, 1969).

The intermediate-coupling version of the unified nuclear model was used to describe the odd-mass isotopes of lanthanum and cesium. Results are presented and compared to experiment for energy spectra, magnetic and quadrupole moments, and M1 and E2 transition rates. (auth)

23715 THE HALF-LIFE OF THE FIRST METASTABLE STATE IN ^{90}Nb. Geiger, J. S.; Graham, R. L.; Johns, M. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 47: 949-51(Apr. 15, 1969).

A delayed γ activity, $E_\gamma = 122.2 \pm 0.2$ keV, $t_{1/2} = 18.82 \pm 0.09$ s, is observed following 10-MeV proton bombardment of targets of natural Zr and of natural Hf, in which Zr is present as a contaminant. The present results, taken together with other recently published data, show that this activity arises from ^{90}Zr(p,n)^{90m}Nb. The tentative assignment of this 122-keV γ activity to ^{179}Ta, which was proposed in a previous publication, is withdrawn. (auth)(Canada)

23716 KINETIC ENERGY RELEASE IN REACTOR NEUTRON-INDUCED FISSION OF ^{232}Th. Prakash, Satya; Manohar, S. B.; Rao, C. L.; Ramaniah, M. V. (Bhabha Atomic Research Center, Trombay, India). J. Inorg. Nucl. Chem., 31: 1217-24(May 1969).

Ranges of eleven fission products produced in the reactor neutron fission of ^{232}Th were determined radiochemically using the thick target-thick catcher technique. Kinetic energies of the fission fragments were calculated from the ranges and the kinetic energy deficit in the symmetric fission region was estimated to be 28.5 MeV. A simple correlation of kinetic energy deficit with shell structure was attempted in the fission of ^{232}Th, ^{233}U, ^{235}U, ^{238}U, ^{237}Np, ^{239}Pu, and ^{241}Pu. (auth)(UK)

23717 THE HALF-LIVES OF ^{245}Cm, ^{246}Cm, ^{248}Cm, ^{250}Cf, ^{251}Cf, AND ^{249}Cf. Metta, D. N.; Diamond, H.; Kelly, F. R. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 31: 1245-50(May 1969).

The partial α half-lives of ^{245}Cm, ^{246}Cm, ^{248}Cm, ^{250}Cf, ^{251}Cf, and

^{249}Cf were determined to be 8265 ± 180 yr, 4711 ± 22 yr, 3.84 ± 0.04 × 10^5 yr, 13.08 ± 0.09 yr, 900 ± 50 yr, and 352 ± 6 yr, respectively. Partial spontaneous fission half-lives of 1.80 ± 0.01 × 10^7 yr and 4.22 ± 0.12 × 10^6 yr were determined for ^{246}Cm and ^{248}Cm, respectively. (auth)(UK)

23718 GAMMA-RAY SPECTROMETRIC MEASUREMENTS OF THE CAPTURE CROSS SECTION OF ^{198}Au FOR REACTOR NEUTRONS. Cabell, M. J.; Wilkins, M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 31: 1229-40(May 1969).

By using a calibrated gamma-ray spectrometer to measure the absolute disintegration rates of ^{198}Au and ^{199}Au in mixtures of the two, the capture cross section of ^{198}Au for reactor neutrons, $\hat{\sigma}_0$, was measured as a function of Westcott's epithermal index parameter, $r\sqrt{T/T_0}$, over the range encountered in the high-flux irradiation positions of the PLUTO reactor. Assuming the 2200 m/sec capture cross section of ^{59}Co to be 37.4 barns it was found that $\hat{\sigma}_0$(barns) = 25102 − 46535 $r\sqrt{T/T_0}$. The capture cross section for Maxwellian neutrons (T = 70°C) was found to be 25102 ± 371 barns. (auth)(UK)

23719 A MEASUREMENT OF THE K CONVERSION COEFFICIENT OF THE 570-keV TRANSITION IN ^{207}Pb. Hedin, G.; Baecklin, A. (Univ. of Uppsala. Swedish Research Councils Lab., Studsvik). Ark. Fys., 38: 593-8(1969).

The K-conversion coefficient of the 570-keV E2 transition was measured to 1.55 ± 0.06 × 10^{-2}, in good agreement with theory but in contradiction with a recently reported measurement by Rizvi and Sen. The relative intensities of the K, L, and M lines of the 570- and 1064-keV transitions in ^{207}Pb were measured with an accuracy of 2 to 5 percent. (auth)(Sweden)

23720 DETERMINATION OF THE MEAN LIFE OF SOME EXCITED NUCLEAR STATES BY MOESSBAUER EXPERIMENTS. Steiner, P.; Gerdau, E.; Hautsch, W.; Steenken, D. (Institut fuer Experimentalphysik, Hamburg). Z. Phys., 221: 281-90 (1969).

Mean lives of several excited nuclear states were determined using the Moessbauer effect. The mean life was deduced by interpolating the experimental line width to zero effective thickness of the resonance absorber. An improved expression was used for the interpolation. The results are: τ(140 keV level of ^{99}Tc) = 277(14)ps, τ(136 keV level of ^{181}Ta) = 55(3)ps, τ(129 keV level of ^{191}Ir) = 129(2)ps, τ(139 keV level of ^{193}Ir) = 115(3)ps, and τ(77 keV level of ^{197}Au) = 2.73(2)ns. (auth)

23721 DECAY OF ^{106g}Rh. Strutz, Kl.-D.; Strutz, H.-J.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys., 221: 231-44(1969). (In German).

The gamma rays associated with the decay of ^{106g}Rh were investigated using several sizes of Ge(Li)-counters and a Ge(Li)-NaI(Tl)-coincidence circuit. Energies and relative gamma intensities of 107 transitions were determined. All except 5 transitions were placed in a level scheme of ^{106}Pd having states at 0, 0^+; 511.8, 2^+; 1,128.0, 2^+; 1,133.6, 0^+; 1,228.9, 4^+; 1.557.6, 3^+; 1,561.9, 2^+; 1,706.1, 0^+; 2,001.0, 0^+; 2,242.4, 1, $2^{\pm}$; 2.278.0, 0^+; 2,308.6, 1, 2^+; 2,350.8, 4^+; 2,438.6, 1, 2^+; 2,500.4, 0^+; 2,525.3, 1, $2^{\pm}$; 2,624.4, 0^+; 2,706.6, 1, 2^+; 2,741.0, 1, $2^{\pm}$; 2,783.5, $(2)^{\pm}$; 2,821.2, 2^+; 2,829.8, 0^+; 2,878.3, 0^+; 2,902.7, 2^+; 2,917.8, 2^+; 3,027.1, 1, $2^{\pm}$; 3,037.2, 1, 2^+; 3,055.2, 1, 2^+; 3,083.2, 2^+; 3,163.4, 1, 2^+; 3,167.5, 1, 2^+; 3,221.2, 0^+; 3,295.6, 0^+; 3,321.3 keV, 0^+. (auth)

23722 DECAY ENERGY OF ^{183}Re → ^{183}W. Kuhlmann, E. (Univ., Freiburg i.B.); Loebner, K. E. G. Z. Phys., 222: 144-54 (1969).

The electron capture decay energy of ^{183}Re was determined from the fraction of K-capture in the transition of the 453.08-keV level in ^{183}W by delayed coincidences. From this value the total decay energy from ^{183}Re → ^{183}W is obtained to be Q = 555 keV according to the theory of Brysk and Rose with corrections of Bahcall. The resulting log ft values and consequences for the decay scheme are discussed. (auth)

23723 PROPERTIES OF ROTATIONAL BANDS IN ^{181}Re, ^{182}Re, AND ^{183}Re. Hjorth, S. A.; Ryde, H.; Skanberg, B. (Research Inst. of Physics, Stockholm. Univ. of Stockholm). Ark. Fys., 38: 537-54(1969).

The gamma rays emitted from a ^{181}Ta target bombarded by 28-, 38-, and 42-MeV alpha particles were observed with a Ge(Li) detector. Energies, relative intensities, and angular distributions of gamma rays due to transitions in ^{181}Re, ^{182}Re, and ^{183}Re were determined. In each nuclide two rotational bands were found to be strongly populated, and six to eight members of these bands were identified. The experimental level energies were analyzed in the framework of the unified model, and the values of higher order correction terms were determined. (SWEDEN)

23724 SEARCHES FOR ELEMENT 105. Ponizovskii, Z. L. Priroda, No. 11, 71-4(Nov. 1968). (In Russian).

Some experiments performed in search of element 105 are reviewed. The general scheme of the experiments is to produce element 105 by the bombardment of ^{243}Am with ^{22}Ne nuclei, producing isotopes 261 and 260 of element 105 and 4 to 5 neutrons. The lifetime of these nuclei is calculated to be 0.01 to 0.1 sec; the method of analysis chosen is collection of nuclei and registration of energies of emitted particles. The isotopes are calculated to release 9.1- to 9.8-MeV α particles; ^{260}105 would produce ^{256}Lw, which decomposes in 35 sec releasing a 8.35- to 8.6-MeV α particle. Registration of both particles would constitute analysis of ^{260}105. One such coincidence was observed in experimentation. Also, statistical analysis of data obtained from newer detectors where first and second impulses are observed shows that for second impulses of 8.35 to 8.6 MeV, the fraction of first impulses in the range 9.1 to 9.8 MeV is significantly greater than those of energies on either side. Further experiments suggest two isotopes of 105: one with E_α of 9.4 ± 0.1 MeV and $t_{1/2}$ of 0.1 to 3 sec, and one with E_α of 9.7 ± 0.1 MeV and $t_{1/2}$ of >0.01 sec. Experiments directed to production of element 114 are noted. (BBB)

23725 AN ACCURATE DETERMINATION OF THE CADMIUM RATIO OF NEUTRON CAPTURE RATES IN ^{238}U IN SLIGHTLY ENRICHED URANIUM. Ertek, C.; Yalcin, A.; Inel, Y. (Cekmece Nuclear Research and Training Center, Istanbul). Nucl. Sci. Eng., 36: 209-19(May 1969).

An experimental method of determining the ratio of the epicadmium ^{238}U neutron-capture rate to the subcadmium ^{238}U capture rate in a fuel rod, (ρ^{28}), is presented. The precision is ~0.3% on the cadmium ratio. The relative ^{239}Np and fission-product activities induced in a representative cross section of the fuel material (a thin bare foil of natural uranium) are compared with those induced in a cadmium-covered identical foil in a "flux symmetric" position in the rod. The ^{239}Np gamma activity is counted by a coincidence method with and without the application of chemical separation. The results from the coincidence method are compared with two single-channel and one hundred-channel analyzer results obtained by chemical separation. (auth)

23726 MEASUREMENT OF X RAYS AS A FUNCTION OF MASS IN THE THERMAL FISSION OF ^{235}U. Bohn, Edward Michael. Urbana, Ill., Univ. of Illinois, 1968. 126p.
Thesis.

X rays were measured as a function of fission fragment mass in the thermal fission of ^{235}U. Specifically, the measurement concerned the x rays of energies between 10 and 45 keV produced as excited fission fragments de-excite by the internal conversion process. These x rays are characteristic of the nuclear charge of the fragment and, thus, information about the division of nuclear charge in fission was obtained. The fission fragments were detected by silicon surface barrier detectors and the x rays were detected with a NaI(Tl) scintillator. A triple coincidence system recorded the energies of the two fragments and the x rays emitted by the fragments. The masses of the two fragments were computed from the fragment energies and conservation of momentum. The x ray spectra were sorted into mass groups 4 amu wide to give the following information: x-ray spectra for various mass groups in fission. X-ray yields as a function of fragment mass. X-ray yields as a function of total fragment kinetic energy. The x-ray spectra were analyzed to give the most probable charge, Z_p, for each mass group. These values of Z_p agree with the empirical Z_P curve derived from radiochemical work. The x-ray yields as a function of fragment mass are compared to the x-ray yields from ^{252}Cf fission fragments and found to have many features in common with the ^{252}Cf yields. These features are interpreted in terms of the nuclear systematics of deformed nuclei. The x-ray yields as a function of total fragment kinetic energy show features which can be explained by assuming a constant excitation energy available in fission. (Disser. Abstr.)

23727 A SEARCH FOR THE ONE HOUR PERIOD OF ^{186}Re. Facetti, J. F.; Velez de Santiago, M. Rev. Soc. Cient., 8: No. 1, 4-7(1967). (In Spanish).

A search for the one-hour period ^{186}Re is described. Samples of rhenium, enriched in ^{185}Re, were irradiated with neutrons. No one hour activity was found. (auth)

23728 PHOTOFISSION OF ^{238}Pu AND ^{239}Pu. Shapiro, Alvin. Cincinnati, Univ. of Cincinnati, 1968. 106p.
Thesis.

The photofission yield of ^{238}Pu and ^{239}Pu, produced by the bremsstrahlung beam from the University of Cincinnati betatron, was measured between 7.5 and 11.5 MeV. Corona discharge spark chambers were used to detect fission fragments in the presence of the very high natural alpha activity of plutonium.

The cross sections were deduced from the measured yields by the Penfold–Leiss procedure. The cross section results for the two isotopes were within statistical accuracy of each other, indicating that the fissionability of ^{238}Pu adheres to the Z^2/A dependence predicted by the liquid drop model and observed with other isotopes. Both cross sections exhibit the rapid increase with energy expected in this energy range, owing to the onset of the giant resonance associated with photonuclear reactions. The operating characteristics of the recently modified University of Cincinnati betatron were calibrated by measuring the bremsstrahlung spectrum (i.e., the relative number of photons per energy interval), the variation in the maximum bremsstrahlung energy with the energy control setting, and the total number of photons produced by the betatron. The spectrum was measured with a 5-inch diameter by 4-inch thick NaI scintillation spectrometer and 200-channel analyzer. The pulse-height spectra were converted in incident photon spectra by a matrix inversion calculation. Good agreement between the experimentally determined spectra and the theoretical bremsstrahlung spectra derived by Schiff was obtained. The maximum bremsstrahlung energy was varied by directing the electron beam into the target at preselected times in the acceleration cycle of the betatron. The energy control parameter is the time duration, Δt, between the point of zero magnetic field and the destruction of the electron beam on an internal target to produce the bremsstrahlung. The maximum bremsstrahlung energies at various Δt settings were obtained from the NaI data. In addition, these energies were checked against known (γ,n) threshold energies as measured by BF_3 neutron detectors embedded in paraffin. These two independent methods of measurement confirmed the energy calibration through their self-consistent results. The maximum bremsstrahlung energy (or electron energy) should vary sinusoidally, as does the magnetic field of the betatron, with Δt. This was found to be the case, and the energy calibration is considered accurate to within 3%. The photon intensity produced by the betatron was measured with a replica of a calibrated National Bureau of Standards ion chamber. The NBS calibration curve used with the replica chamber was checked against results obtained with a Victoreen Roentgen Meter. Good agreement was obtained so that the replica chamber with the NBS calibration curve provides a suitable means for monitoring the betatron photon intensity. The typical dose rate at the time of calibration for the maximum betatron energy of 11.7 MeV was 12.6 roentgens per minute at one meter. (Disser. Abstr.)

23729 THE SIGNS OF E2, M1 TRANSITION MATRIX ELEMENTS OF THE TUNGSTEN, OSMIUM, AND PLATINUM NUCLEI. Kumar, K. (Univ. of Copenhagen). Phys. Lett., 29B: 25-8 (Mar. 31, 1969).

A previous calculation is extended to give the signs of E2, M1 transition matrix elements, which are of interest in connection with the Coulomb excitation measurement of quadrupole moments and B(E2) values, and the angular correlation measurement of E2/M1 mixing ratios. (auth)

23730 CALCULATION OF NEUTRON AND PROTON DISTRIBUTION IN ^{208}Pb. Pandharipande, V. R. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 29B: 1-4(Mar. 31, 1969).

The distribution of neutron and proton densities in ^{208}Pb is calculated with a very realistic representation of G in nuclear matter. It is found that the neutron radius is larger than the proton radius by 0.2 fm, the half-density radius is the same for both the nucleons, and the ratio of neutron and proton surface thickness is 1.27. (auth)

23731 SHELL MODEL DESCRIPTION OF THE 0^+-ISOBARIC ANALOGUE RESONANCE IN ^{208}Bi. Sandner, P.; Drysdale, N. (Univ., Heidelberg). Phys. Lett., 29B: 9-11(Mar. 31, 1969).

The schematic isobaric analog resonance theory of Weidenmueller was modified, and calculations were performed for the ^{208}Pb ground state, seen in proton scattering on ^{207}Pb. The calculated reduced widths are in good agreement with experiment. (J.W.R.)

23732 EMISSION OF LIGHT NUCLEI IN THERMAL NEUTRON FISSION OF ^{239}Pu. Krogulski, T.; Chwaszczewska, J.; Dakowski, M.; Piasecki, E.; Sowinski, M.; Tys, J. (Inst. of Nuclear Research, Warsaw). Nucl. Phys., A128: 219-23(1969).

The relative intensities and energy spectra of ^{1}H, ^{2}H, ^{3}H, ^{4}He, ^{6}He, and ^{8}He particles from thermal neutron fission of ^{239}Pu were measured. The comparison with analogous data on the spontaneous fission of ^{252}Cf and the thermal neutron fission of ^{235}U reveals a pronounced similarity. (auth)

23733 STUDY OF THE ^{208}Pb(d,p)^{209}Pb REACTION AT ENERGIES ABOVE AND BELOW THE COULOMB BARRIER. Jeans, A. F.; Darcey, W.; Davies, W. G.; Jones, K. N.; Smith, P. K. (Oxford Univ.). Nucl. Phys., A128: 224-40(1969).

The ^{208}Pb(d,p)^{209}Pb reaction was studied at deuteron bombarding energies of 8, 9, 10, 16.5, and 18.7 MeV. The single-particle character of the low-lying levels of ^{209}Pb was exploited to assess the accuracy of the spectroscopic factors obtained from a distorted-wave Born approximation analysis of the proton angular distributions. Various corrections to the standard zero-range calculations are investigated, and the special advantages of the experiments performed at energies below the Coulomb barrier are evaluated. (auth)

23734 NEW ISOMERIC STATE IN N = 81 NUCLEI: ^{145m}Gd. Jansen, G.; Morinaga, H.; Signorini, C. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A128: 247-55(1969).

A new $11/2^- - 3/2^+$ isomeric transition was found in ^{145}Gd from the ^{144}Sm(^{3}He,2n) reaction. Its energy measured with a Ge(Li) detector was 721.3 ± 0.7 keV and the half-life was 85 ± 7 sec. Energies of "analogous" $11/2^-$ isomeric states in the other N = 81 nuclei ^{143}Sm, ^{141}Nd, and ^{139}Ce were measured with a Ge(Li) detector; their energies were determined to be 754.4 ± 0.7, 756.5 ± 0.7, and 754.4 ± 0.7 keV, respectively. The M4 transition probabilities in N = 81 nuclei were compared with theoretical estimates corrected for effects of configuration mixing and changing of radial matrix elements with nuclear radii. (auth)

23735 DECAY SCHEME OF ^{139}Ba. Berzins, G.; Bunker, M. E.; Starner, J. W. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys., A128: 294-304(1969).

The decay scheme of ^{139}Ba was investigated with high-resolution Ge(Li) and Si(Li) detectors. The results of NaI(Tl)-Ge(Li) coincidence experiments, complemented by energy-sum arguments, suggest a level scheme in ^{139}La with excited states at 166, 1219, 1257, 1382, 1420, 1477, 1536, 1558, 1578, 1683, 1762, 1768, 1857, 1922, 1963, and 2061 keV, which accommodates all of the 28 observed gamma-ray transitions. The results are compared with earlier Coulomb excitation and $(n,n'\gamma)$ experiments and with recent ^{138}Ba(^{3}He,d) and decay-scheme studies. (auth)

23736 K/L_3, M/L, AND (N + O + ...)/M RATIOS FOR 239-keV M1 TRANSITION IN ^{212}Bi. Krpic, D.; Stepic, R.; Bogdanovic, M.; Mladenovic, M. (Inst. Boris Kidric, Belgrade). Fizika (Zagreb), 1: 171-2(1969).

Conversion ratios for the 239-keV transition in ^{212}Bi were measured and were compared with theoretical predictions. (D.C.W.)

23737 DIRECTIONAL GAMMA–GAMMA ANGULAR CORRELATION OF THE 71.66- TO 249.69-keV CASCADE IN ^{177}Hf. Hrastnik, B.; Ljubicic, A.; Basar, I.; Diksic, M.; Ilakovac, K.; Jurcevic, M.; Knapp, V.; Vojnovic, B. (Inst. Ruder Boskovic, Zagreb). Fizika (Zagreb), 1: 117-26(1969).

A Ge(Li)–NaI(Tl) angular correlation system with a fast-slow electronic coincidence system was used to remeasure the directional angular correlation of the 71.66–249.69 keV cascade in ^{177}Hf. After corrections for finite solid angles the anisotropy ratio of $A = -0.162 \pm 0.026$ was obtained. The upper limit $|\delta| < 0.05$ for the M2/E1 mixing ratio for the 71.66-keV transition was deduced. The results for the angular correlation coefficients are $A_{22} = -0.114 \pm 0.018$ and $A_{44} = 0$. (auth)

23738 EXPERIMENTAL OBSERVATION OF THE SUPPRESSION OF THE INELASTIC CHANNEL OF A NUCLEAR REACTION IN THE INTERACTION OF RESONANT γ RADIATION WITH NUCLEI AND ELECTRONS IN A SINGLE CRYSTAL. Voitovetskii, V. K.; Korsunskii, I. L.; Pazhin, Yu. F. JETP Lett. (USSR) (Engl. Transl.), 8: 376-9(Dec. 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 611-15(Dec. 5, 1968).

The suppression of the inelastic channel in γ scattering by nuclei, which leads to the transparency of the nuclei to resonant γ radiation, was observed in an experiment on Laue diffraction in a perfect single crystal of tin. Such a result can be rigorously justified by the dynamic theory of the resonant interaction of γ rays or neutrons with a regular system of nuclei. (J.W.R.)

23739 STABILITY OF SUPERHEAVY NUCLEI AGAINST FISSION. Mosel, Ulrich; Greiner, Walter (Univ., Frankfurt am Main). Z. Phys., 222: 261-82(1969).

The methods developed in a previous paper were used for the calculation of potential energy surfaces and lifetimes for superheavy nuclei. Two regions of relative stability against spontaneous fission, which are connected with the magic proton numbers Z = 114 and Z = 164 and which will both become accessible for experiments in the near future, are discussed. Especially the nuclei around Z = 164 are investigated for the first time. The lifetimes for α-decay are also estimated and appear to be long enough for experimental work. Furthermore, the dependence of the fission barrier on the level-distributions at the fermi-surface was investigated. The difficulties in the usual microscopic calculations for the fission process are discussed and a way to overcome the limitations and inconsistencies of the usually used Strutinsky-type calculations is shown. (auth)

23740 ELASTIC ELECTRON SCATTERING FROM ORIENTED ^{165}Ho NUCLEI. McCarthy, James Sidney. Stanford, Calif., Stanford Univ., 1968. 175p.

Thesis.

The results for elastic electron scattering from partially aligned ^{165}Ho nuclei are presented. The alignment of the nuclei was perpendicular to the scattering plane and was achieved by means of the "brute force" technique: cooling a single crystal of ^{165}Ho to the temperature of liquid ^{3}He (0.35°K) and using an external field to cause domain alignment in the crystal, with a resulting nuclear alignment from the hyperfine interaction. Differential scattering cross sections are also given for randomly aligned ^{165}Ho nuclei. Detailed comparison of the experimental data was made with two separate theoretical calculations. These calculations are the best available in that they do not rely upon the Born approximation, and do take into consideration the excitation of the low-lying rotational levels of ^{165}Ho. By a suitable choice for the nuclear charge distribution some agreement could be obtained with the theoretical predictions. These charge parameters predict an intrinsic quadrupole moment of $8.23 \pm 0.40 \times 10^{-24}$ cm^{2} for the ^{165}Ho nucleus. The value for the quadrupole moment found in this way is not unique and depends upon the model chosen for the charge distribution. It is found that the existing theoretical calculations concerning electron scattering from aligned nuclei are inadequate. Many of the approximations made in these calculations seem to be inconsistent with the experimental results. Further theoretical analysis is necessary before the model dependency of the present nuclear charge parameters may be eliminated. (Disser. Abstr.)

23741 ENERGY LEVELS IN ^{105}Pd. Chandra, Ramesh. Boston, Boston Univ., 1968. 115p.

Thesis.

The decay of ^{105}Ag to the excited states of ^{105}Pd was investigated using high resolution solid state detectors. A singles spectrum with a Ge(Li) detector, coincidence spectra with two Ge(Li) detectors, conversion coefficients for different gamma rays and conversion electron spectra with a Si(Li) detector were measured. As a result, three new gamma rays of energy 54, 75, and 527 keV were identified. There is also a considerable improvement in the accuracy of the branching ratios and the conversion coefficient. Gamma–gamma angular correlation measurements were performed on the 64–280, 331–319, 443–644, 393–280, and 808–280 keV $\gamma-\gamma$ cascades, of which, the last two were not previously measured and the first three were measured by several investigators with poor agreement. In the present work, the ambiguities were avoided by using a Ge(Li) counter in conjunction with a NaI(Tl) counter. The order of the 443–644 gamma cascade was under dispute. The gamma–gamma angular correlation measurement on this cascade fails to distinguish between the two possibilities. To settle between the choices, a conversion electron–gamma angular correlation measurement was done on this cascade and the result unambiguously eliminates choice and thus establishes the order of cascade as 443–644 instead of 644–443. (Disser. Abstr.)

23742 THE NUCLEAR ENERGY LEVELS OF ^{154}Gd. Sperry, Willard Charles. Davis, Calif., Univ. of California, 1968. 158p.

Thesis.

The ^{154}Gd(p,n)^{154}Tb reaction was produced with 10.5 MeV protons. The decays by electron capture of the 7.5- and 20-hour states of ^{154}Tb to ^{154}Gd were examined. Gamma-ray and conversion electron spectra were measured. Thirty-two nuclear energy levels in ^{154}Gd are discussed. The empirically determined structure of ^{154}Gd was compared to several theoretical models of nuclei which have collective motion. Significant disagreements are noted, and the empirical data indicate that the unified model is not satisfactory for ^{154}Gd. (Disser. Abstr.)

23743 OPTICAL PUMPING STUDIES OF ^{107}Cd, ^{109}Cd, ^{111}Cd, ^{113}Cd, AND ^{67}Zn. Spence, Philip Wardwell. Seattle, Univ. of Washington, 1968. 158p.

Thesis.

The nuclear magnetic resonance frequencies of ^{107}Cd, ^{109}Cd, ^{111}Cd, and ^{112}Cd, and ^{67}Zn were measured in vapor samples of these isotopes by the use of an optical pumping technique. ^{111}Cd and ^{113}Cd are stable and have nuclear spin I = $^{1}/_{2}$. Spin $^{5}/_{2}$ ^{67}Zn is the only stable zinc isotope with non-zero nuclear spin. The radioactive isotopes ^{107}Cd and ^{109}Cd both possess nuclear spin I = $^{5}/_{2}$ and have half-lives of 6.7 hr and 470 days. The experiments on the radioactive isotopes represent the first realization of nuclear orientation in an isotope with spin greater than $^{3}/_{2}$. Past attempts to orient ^{67}Zn have been unsuccessful. The optical pumping was carried out by the use of circularly polarized resonance radiation from the $^{3}P_{1} \rightleftharpoons {}^{1}S_{0}$ transition at 3261 Å for zinc and at 3076 Å for cadmium. In separate experiments the nuclear magnetic resonance frequencies of the above isotopes were intercompared through a series of direct frequency ratio measurements with at least two of the isotopes vaporized in the same absorption cell. The ratio of the nmr frequencies of ^{111}Cd and ^{1}H (in mineral oil) was measured by a substitution method. From the results and the known dipole interaction constants for the cadmium isotopes, the differential hyperfine anomalies for the cadmium isotopes were calculated. Comparison of the differential anomalies with those predicted by the configuration mixing nuclear shell model of Arima, Horie, and Noya is shown to lend support to the existence of nuclear ground state configurations with more neutrons in the $(1h_{11/2})$ shell and fewer neutrons in the $(1g_{7/2})$ shell than had previously been assumed. (Disser. Abstr.)

23744 THE MEASUREMENT OF $\beta-\gamma$ DIRECTIONAL CORRELATIONS IN ^{122}Sb AND THE EXCITED STATES IN ^{122}Te. Aoki, Atsushi; Kawamura, Mitsuhiro (Kyoto Univ.). Sci. Rep. Kyoto Prefect Univ., No. 19, 1–8(Oct. 1968).

The decay of ^{122}Sb was investigated by using a Ge(Li) solid state detector. There was no evidence for the existence of the 1090 keV level of ^{122}Te from γ-ray spectra. The $\beta-\gamma$ directional correlation of the first-forbidden nonunique transition leading to first excited state of ^{122}Te was measured. The angular correlation coefficient A_{22} (ω) varies from 0.049 ± 0.006 to 0.077 ± 0.025 as the β energy increases from 0.75 MeV to 1.25 MeV. The results are consistent with the prediction of the ξ approximation. A modified B_{ij} approximation was used to investigate the structure of the first excited state of ^{122}Te. Three configurations $(g^{7}/_{2})^{4}$ $(h^{11}/_{2})^{\nu}$, $(g^{7}/_{2})^{r}$ $(h^{11}/_{2})^{4}$, $(g^{7}/_{2})^{r}$ $(h^{11}/_{2})^{6}$ are not inconsistent with the experimental data. (NSA of Japan)

Nuclear Theory

Refer also to abstracts 21681, 21738, 23389, 23392, 23637, 23656, 23661, 23665, 23677, and 23738.

23745 (AD–673524) TABLE OF CENTRAL-FORCE GEOMETRICAL COEFFICIENTS ASSOCIATED WITH TALMI INTEGRALS FOR USE IN CALCULATING NUCLEAR TWO-BODY MATRIX ELEMENTS USING HARMONIC OSCILLATOR WAVE FUNCTIONS. Langworthy, J. B.; Podgor, S. (Naval Research Lab., Washington, D. C.). June 7, 1968. 61p. (NRL–6733). CFSTI.

In calculating nuclear two-body matrix elements using harmonic oscillator wave functions, the radial parts give Talmi integrals and the angular parts may be done by Racah algebra, yielding the geometrical coefficients tabulated here. This table is calculated from the harmonic oscillator transformation brackets and B coefficients of Moshinsky. The table is applicable to the calculation of central-force matrix elements for nuclides containing up to 70 nucleons of a single species and is accurate to at least seven significant figures. (auth) (USGRDR)

23746 (AECL–3257) PHYSICS DIVISION. Progress Report, October 1–December 31, 1968. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 83p. (PR-P–80). Dep. CFSTI. CAN $2.00.

A beam of ^{14}N ions was obtained for the first time and was used for a preliminary investigation of reactions with ^{12}C, ^{16}O and ^{32}S nuclei. The analyzed beam current was in excess of 150 nA, of $^{14}N^{4+}$ at 30 MeV. A new method for measuring static quadrupole moments in light nuclei was developed. The reorientation effect in heavy-ion Coulomb excitation is determined from an accurate comparison of the inelastic scattering cross section at two discrete CM angles, corresponding to the detection of a scattered projectile or a recoiling target nucleus in a single surface-barrier detector. The unresolved elastic peaks are eliminated by demanding coincidences with gamma rays detected in six NaI(Tl) counters mounted on the LOTUS goniometer; the attenuation of the gamma-ray anisotropy due to magnetic hyperfine interaction in the highly ionized recoil atoms is determined experimentally. In an experiment with a 62 MeV $^{35}Cl^{6+}$ beam the static quadrupole moment of the first excited state of ^{24}Mg was measured to be -0.243 ± 0.035 b. A study by other methods of reorientation effects in the Coulomb excitation of ^{28}Si by 60 MeV $^{32}S^{6+}$ ions has led to a (preliminary) value of about +0.5 b for the static quadrupole moment of the first excited state of ^{28}Si, significantly higher than the 0.15 ± 0.02 b prediction of the rotational model. Further studies of the ^{239}Pu(d,pf) reaction were carried out, with a fission fragment counter array in the target chamber of the magnetic spectrograph operated in coincidence with protons detected in the focal plane spark chamber. Preliminary analysis of a 200-hour run indicates that the peak in fission probability near 5-MeV excitation is made up of several narrow components; the plateau at lower energies also seems to consist of several weak lines. At the NRU reactor, the C-2 neutron chopper, running at 6000 rpm, was used to study the resonance and thermal neutron capture gamma ray spectra from targets of platinum, mercury and indium; the gamma rays are detected in a 23 cm^3 Ge(Li) detector at the end of a 19 m flight path. Analysis of the anomalously strong gamma-ray intensity between 4 and 6 MeV in platinum and mercury is in progress. The angular distribution of fragments from ^{238}U photofission near threshold is being measured with the variable-energy gamma ray facility at NRU. The fragments are detected in a 10 μ plastic film, and preliminary measurements at $E_\gamma = 6.2$ MeV (3% spread) give $W(\theta) = 1 + \alpha \sin^2\theta$ with $\alpha = 1.7 \pm 0.2$. The C5 triple axis spectrometer at NRU was used to carry out coherent neutron inelastic scattering experiments on DHMT (deuterated hexamethylenetetramine) at 100°K in order to determine the dispersion relation of the lattice modes propagating along several important symmetry directions; measurements at 296°K had been made previously (PR-P-77 : 4.2). Several modes (e.g., H_{15}', N_3', P_4) show a substantial frequency change between 296°K and 100°K, but others (e.g., P_5, H_{15}) are virtually unchanged. The most significant new result is for Γ_{15}' and the associated Δ_6O branch; Γ_{15}' was previously reported to have a frequency of 1.08 THz but this is now believed to be an error, the correct value at 296°K being 1.75 THz. The scattered neutron groups corresponding to the frequency 1.08 almost certainly arise from incoherent scattering by the small amount (2%) of hydrogenous HMT in the specimen. Reinterpretation of both the earlier 296°K results and the new 100°K data has led to a new model for the lattice dynamics of DHMT. Measurements at a series of temperatures were carried out on a single crystal of KBr with the C5 triple axis spectrometer in order to determine experimentally the effect on phonon groups of the anharmonic interference between the one- and two-phonon scattering processes. Previous calculations had suggested that this interference causes changes in intensity and frequency that are strongly wave-vector dependent. A preliminary analysis of the results suggests that a significant effect on the intensity of the neutron groups has been observed, as predicted, for the longitudinal optic modes. The experimental results obtained on the critical scattering of potassium dideuterium phosphate (DKDP) have now been analyzed in terms of the Ising model. In this model the scattering cross-section at momentum transfer, Q, is given by $|f(Q)|^2 \times (1 + \beta V(Q))^{-1}$, where f(Q) is the structure factor of the ferroelectric fluctuations and V(Q) the Fourier transform of the interaction between the neighbouring unit cells. The form factor f(Q) may be described as arising largely from the displacements of the K, P and D atoms, the amplitude of the displacements being qualitatively similar to those in the phase transition of KH_2PO_4. The interaction was shown to arise partly from neighbouring ions and partly from the long-range electric fields. The magnitude of the nearest-neighbor interaction was deduced and some evidence found for the need of second-neighbor interactions. The long-range fields appear to be about an order of magnitude less than expected from the Curie constant. A series of measurements is being made of the performance of several Si(Li) detectors over a wide range of temperature, and charge collection studies are being continued in a set of Ge(Li) detectors showing preferential electron trapping. More detectors have been made from Ge crystals grown at ORF. Crystal No. 9, the most nearly perfect grown so far, was disappointing and has yielded no good spectrometers. Crystals No. 10 and No. 11 were pulled mainly for furnace data and operational checks but some small portions of No. 11 are being made into detectors and further coaxial detectors are being made from No. 5. To speed up the assessment of ORF crystals some evaluation work has been started at the RCA Victor Research Laboratories in Montreal. Evidence of inclusions in some of the raw Ge ingots and problems associated with scum on the melt surface have led to a decision to install a zone refining furnace at ORF. No suitable commercial unit has been found and the furnace is being designed and built at ORF. (auth)

23747 (AERE-R-5911) EVALUATION OF LEAST SQUARES METHODS OF ANALYSING DECAY DATA. Robinson, D. C. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1968. 25p. Dep. CFSTI. UK 4s. 0d.

The common method of analyzing decay curves by fitting a straight line to the logarithm of the decay curve using the reciprocals of the numbers of counts per channel as weights was found to introduce an error of the order of 0.5% in the lifetime. The dependence of this error on the number of counts accumulated, the number of half-lives analyzed, and the background can be described by an empirical formula. It is shown that a much better method is to use an iterative procedure to fit an exponential to the counts observed, using the numbers produced by the fit as weights instead of the actual counts. (auth)(UK)

23748 (ANU-P-429) SOME COMMENTS ON THE ANALYSIS OF EXCITATION FUNCTIONS USING DIFFERENT TRANSFORMS. Hellstroem, Jan (Australian National Univ., Canberra. Research School of Physical Sciences). [nd]. 10p. Dep.

The application of Fourier transforms to the statistical analysis of excitation functions is discussed, using the determination of the mean level width as an example. It is shown that other transforms are possible. (D.C.W.)

23749 (IAE-1593) SINGLE-PARTICLE LEVELS OF SPHERICAL NUCLEI. Fayans, S. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1968. 36p. (In Russian). Dep.

A single-particle spectrum of a series of spherical nuclei is found using the method of numerical integration of the Schroedinger equation with a Woods–Saxon potential. Graphs of the radial wave functions of a discrete and quasidiscrete spectrum are given. Tables of the single-particle matrix elements and of the integrals of a product of four wave functions appearing in the examination of the transitions with different selection rules are shown. (auth)

23750 (ITF-68-83) FOUR PARTICLE SYSTEM GROUND STATE. Ol'khovskii, V. S.; Recami, E. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 20p. Dep.

The bound states of four-particle systems, particularly the ground states, are calculated using a rather general expression for the two-body central attractive potentials. Initially, a Hamiltonian expansion in the strong-coupling-constant approximation is used; recourse is then made to the harmonic polynomial method. The latter method is found to be quite valid; good agreement with other calculations for the ground-state energy of the alpha particle is obtained using Yukawa potentials. (auth)

23751 (JINR-P2-4306) SEMIEMPIRICAL FORMULA FOR DOUBLE DIFFERENTIAL CROSS SECTIONS OF SECONDARY NUCLEON PRODUCTION IN BOMBARDING THE NUCLEI BY THE NUCLEONS WITH THE ENERGY OF SEVERAL HUNDREDS OF MeV. Sychev, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). [1969]. 24p. (In Russian). Dep.

Spectral-angular distributions of secondary high-energy nucleons ($E > 20$ MeV) in nucleon-nucleus interactions are presented as analytical expressions. The quasi-elastic scattering nucleons and cascade nucleons are identified among the secondary particles. (auth)

23752 (KURRI-TR-14) AUTOMATIC ANALYSIS OF INTERNAL-CONVERSION ELECTRON SPECTRA WITH AN ELECTRONIC COMPUTER. Yamada, Shigeru; Hayashi, Takeo; Matsui, Hiroshi; Ohira, Kyozo (Kyoto Univ. (Japan). Research Reactor Inst.). [1965]. 14p. (In Japanese). Dep.

The spectrum of internal-conversion electrons obtained by a magnetic spectrometer consists of a number of overlapping peaks. A method for separating the individual peaks from the overlapping spectrum to allow the determination of individual intensities and momenta is described, citing as an example the data for ^{110m}Ag. The theory of the method is discussed along with practical experimental applications. The error in the results is calculated by a least squares approach. The programming of the calculations for adaptation to computers is described. (TTT)

23753 (MIT-2098-492) BOUND AND CONTINUUM STATE OPTICAL MODEL CODES FOR NONLOCAL POTENTIALS. Bartels, E. C.; Kerman, A. K.; MacKellar, A. D. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). June 1968. Contract AT(30-1)-2098. 98p. Dep. CFSTI.

A method for calculating potential scattering from doubly closed shell nuclei using the Hartree–Fock nonlocal potential is described. The method can be used for solving the Schroedinger equation with nonlocal potentials for either scattering or bound states. Two FORTRAN IV codes based upon this method are described. NLCNT, for calculation of continuum state wave functions; and NLBND, for calculation of bound state energies and wave functions. (D.C.W.)

23754 (NP-17814) THEORY OF NUCLEAR STRUCTURE. Waghmare, Yeshwant R. (Australian National Univ., Canberra. Dept. of Theoretical Physics). May-July 1968. 184p. Dep.

Elements of the theory of nuclear structure are presented under the following headings: angular momentum in quantum mechanics, coupling of angular momentum and vector coupling coefficients, rotation operators, matrix elements of tensor operators, two-particle interactions, three- and many-particle configurations, particle–hole interactions, pairing theory, and theory of finite nuclei. Formulas are derived explicitly, and their applications are demonstrated. 72 references. (D.C.W.)

23755 (ORNL–4379) EVAP-2 AND EVAP-3: MODIFICATIONS OF A CODE TO CALCULATE PARTICLE EVAPORATION FROM EXCITED COMPOUND NUCLEI. Guthrie, M. P. (Oak Ridge National Lab., Tenn.). Mar. 1969. Contract W-7405-eng-26. 37p. Dep. CFSTI.

The EVAP computer programs calculate the types, multiplicities, and energy distributions of particles evaporated from excited compound nuclei. The modifications incorporated in EVAP-2 include updating the nuclear masses and shell-plus-pairing energy corrections used as input data, providing for the breakup of ^{8}Be, and eliminating the possibility of the evaporation residual nucleus having a negative excitation energy. EVAP-3 retains all of the modifications of EVAP-2 and, in addition, calculates the kinetic energies of the recoiling nuclei. The codes are written in FORTRAN-IV and operate on the IBM-360 computer. Data cards and the printed output for a sample case are shown. (auth)

23756 (ORO–2408-10) ATOMIC PERTURBATIONS IN NUCLEAR REACTIONS. Coleman, Lawrence Arnold (North Carolina Univ., Chapel Hill). 1969. 74p. Dep. CFSTI.

Thesis.

Recent experimental advances in the resolution of cross section measurements of nuclear resonances have made it desirable to investigate the effects of the atomic environment on such measurements. Single-atom processes are studied in which the reacting projectile interacts with the atomic electrons, causing ionization. This ionization produces changes in the resonance line shape so that isolated nuclear resonances no longer have the simple, symmetric, Breit-Wigner form. A simplified model of the atom is assumed in which there is only one excited state, and the electron-projectile potential is adjusted so that this single state can approximately represent the infinite number of real states. The criterion used requires that the total excitation probability for the model be equal to that for the particular atomic shell being considered. The R-matrix theory of nuclear reactions forms the basis for the calculation. The two-state model of the atom allows the Schroedinger equation to be expressed as a pair of coupled differential equations with the elimination of the electronic coordinates. These equations permit the appropriate definition of internal and external states as required by the R-matrix theory. The theory is then developed for an isolated nuclear resonance. In order to obtain a numerical estimate of the magnitude of the effect, the formal theory is specialized to the s-wave elastic scattering of 1.17 MeV protons on ^{20}Ne with a width of 8 eV. The result is that ionization from the L_{II} or L_{III} subshells of Ne occurs in about 30% of the scattering processes. This value is shown to be consistent with estimates obtained from Levinger's calculations of the effects of alpha and beta disintegrations on inner-shell electrons. (auth)

23757 EFFECT OF TENSOR FORCES IN THE DEUTERON–NUCLEUS INTERACTION ON DWBA CALCULATIONS FOR (d,p) REACTIONS. Delic, G.; Robson, B. A. (Australian National Univ., Canberra). Nucl. Phys., A127: 234-40(1969).

The effect of possible tensor forces in the deuteron-nucleus interaction on DWBA calculations for deuteron stripping was studied for l = 1 transitions in the ^{40}Ca(d,p)^{41}Ca reaction leading to the 2.47 MeV ($3/2^-$) and 3.95 MeV ($1/2^-$) levels. The j-dependence of the cross sections and vector analyzing powers was investigated. (auth)

23758 SECOND-QUANTIZED FORMULATION OF INELASTIC SCATTERING INCLUDING CORE POLARIZATION. Love, W. G. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A127: 129-40 (1969).

The second-quantization formalism of Villars was applied to nucleon-nucleus inelastic scattering. Both the direct and knockout terms were found to require renormalized effective interactions. Each term is characterized by its own state-dependent coupling constant. Explicit formulas are presented to indicate how these core polarization terms may be included in a "conventional" anti-symmetrized distorted-wave calculation. (auth)

23759 ANALYTIC EXPRESSIONS FOR PARTICLE SPECTRA OF SEQUENTIAL THREE-BODY BREAK-UPS. Morinigo, Fernando B. (Institut de Recherches Nucleaires, Strasbourg. California State Coll., Los Angeles). Nucl. Phys., A127: 116-28 (1969).

Analytic expressions are developed, which are capable of describing the shape of the continuous particle spectra observed at a fixed angle in sequential nuclear reactions, for axially symmetric but otherwise arbitrary angular distributions of the first and second break-up, when the intermediate state has a definite energy. Analytic expressions are also developed for the spectra expected in the case of intermediate states, which have the shape of simple resonances. The generalization to intermediate broad states of arbitrary energy dependence is indicated. (auth)

23760 VALIDITY OF PERTURBATION APPROACH TO TWO-STEP STRIPPING. Iano, P. J. (Case Western Reserve Univ., Cleveland); Penny, S. K.; Drisko, R. M. Nucl. Phys., A127: 47-59(1969).

The perturbation method of handling inelastic coupling is compared to the more accurate coupled-channels method insofar as such coupling affects the deuteron stripping reaction. In the cases where the two-step (indirect) transition amplitude is comparable to the one-step (direct) transition amplitude, the perturbation method yields poor fits to the angular distributions. However, the perturbation method reproduces the peak cross sections rather well. (auth)

23761 COUPLED ONE-PARTICLE STATES OF NUCLEONS IN A SPHERICAL POTENTIAL. Pasichnyi, A. A.; Tartakovskii, V. K. (Kiev State Univ.). Ukr. Fiz. Zh., 13: 2013-19(Dec. 1968). (In Russian).

One-particle energy levels and wave functions are found for coupled nucleon states in light nuclei in the jj- and LS-coupling schemes by a numerical solution of the Schroedinger equation with the Woods-Saxon potential. The effect of electric interaction on the proton states in the nucleus is taken into account. A comparison is carried out of calculated proton and neutron states in both coupling schemes. Even for the lightest nuclei, proton levels differ noticeably from neutron levels. Dependences are presented of the level position on a molecular number and displacements are shown of the proton levels with the change in the nuclear charge at a fixed molecular number. With the given depth and broadness of the nuclear potential well one fails to attain a good agreement with the experiment simultaneously in both the order of completing shells and the value of average binding energy per nucleon if only the form of the one-particle potential is somewhat changed. To attain a better agreement with the experiment it is probably necessary to make essential perfections in the model under consideration. The wave functions may be easily calculated by the value of the wave functions at a given point estimated and presented in the tables. (auth)

23762 RELATION BETWEEN THE OPTICAL POTENTIALS OF NUCLEONS AND DEUTERONS. Levshin, E. B. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 1939-42(Dec. 1968). (In Russian).

Two methods are proposed, with which one can easily calculate a deuteron optical potential, starting from the optical potentials of the nucleon-nucleus interaction. The potential of the deuteron-nucleus interaction is shown to be approximated by the Woods-Saxon curve. A relation between the parameters of the nucleon optical potentials and those of the deuteron is investigated. It is also shown that the appearance of tensor terms in the expression for the deuteron optical potential may be due to both admixture of the d-wave in the ground state and the dependence of nucleon, optical potentials on the velocity. (auth)

23763 NUCLEAR REACTIONS. Jackson, D. F. (Univ. of Surraey, Guildford, Eng.). Phys. Educ., 4: 82-8(Mar. 1969).

The study of nuclear reactions and information obtained from them are discussed under the following headings: cross sections; nuclear projectiles and their interactions; leptons and mesons used in nuclear structure studies; scattering of electrons by nuclei; nucleons and composite particles used in nuclear structure studies; scattering of nucleons and composite particles by nuclei. (UK)

23764 SYSTEMATIC COMPARISON OF SEMIEMPIRICAL NUCLIDIC MASS EQUATIONS. Wing, James (Argonne National Lab., Ill.). pp 194-233 of Proceedings of the Third International Conference on Atomic Masses, University of Manitoba, Winnipeg, Canada, August 28–September 1, 1967. Barber, R. C. (ed.). Winnipeg, Can., University of Manitoba Press, 1967.

See CONF-670818.

Several methods of comparison of nuclidic mass equations were examined. Each of these comparative methods deals with a particular relationship of the masses of the nuclides not very far from β stability. None of the mass equations under consideration reproduces all the observed mass systematics exactly. Qualitative and quantitative measures of the deviations of the mass equations from the experimental data have revealed inadequate treatment of the nuclear shell effects and poor structure in the equations. The present methods of comparison may be useful for the analysis of a nuclidic mass formula for the possible improvements. Similarities and differences among the mass equations were easily revealed in the comparison. (auth)

23765 TOWARD A SHELL MODEL MASS FORMULA. Bauer, M. (Univ. Nacional Autonoma de Mexico, Mexico City); Canuto, V. pp 234-47 of Proceedings of the Third International Conference on Atomic Masses, University of Manitoba, Winnipeg, Canada, August 28–September 1, 1967. Barber, R. C. (ed.). Winnipeg, Can., University of Manitoba Press, 1967.
See CONF-670818.

An attempt was made to calculate the binding energy per particle in the framework of the shell model. All the terms were deduced with the corresponding analytic expression for their coefficients. A new positive term of the form $A^{-1/3}$ (binding energy per nucleon) is predicted which improves the usual (Bethe–Weiszäcker) mass formula in reproducing the already known regions of deformation. Being of the order of 2 to 3 MeV, it forces the volume energy to be only about 12 MeV. (auth)

23766 CALCULATION OF SEPARATION ENERGIES FOR SPHERICAL NUCLEI. Bleuler, K.; Schuette, D.; Petry, H. (Univ., Bonn). pp 9-19 of Proceedings of the Third International Conference on Atomic Masses, University of Manitoba, Winnipeg, Canada, August 28–September 1, 1967. Barber, R. C. (ed.). Winnipeg, Can., University of Manitoba Press, 1967.
See CONF-670818.

The separation energies for spherical nuclei were calculated using realistic effective two-body forces in conjunction with a Hartree–Bogolyubov approximation. The two-body forces were determined from a generalized Hamada-Johnson expression and the Scott-Moskowsky "cutoff" procedure. The results show the characteristic features of the empirical curve although there are a few minor discrepancies. (J.W.R.)

23767 CALCULATIONS OF NUCLEAR MASSES FROM FIRST PRINCIPLES. Kuemmel, H. G. (Max-Planck-Institut fuer Chemie, Mainz). pp 20-36 of Proceedings of the Third International Conference on Atomic Masses, University of Manitoba, Winnipeg, Canada, August 28–September 1, 1967. Barber, R. C. (ed.). Winnipeg, Can., University of Manitoba Press, 1967.
See CONF-670818.

Methods for approximating the nuclear forces used in the calculation of nuclear binding energies are discussed. The Faddeev method, which treats the three-or many-body problem in rigorous fashion is described in detail. Also discussed are the Hartree-Fock and Brueckner theories. (J.W.R.)

23768 BINDING AND SATURATION OF NUCLEAR MATTER. Sprung, Donald W. L. (McMaster Univ., Hamilton, Ont.). pp 37-57 of Proceedings of the Third International Conference on Atomic Masses, University of Manitoba, Winnipeg, Canada, August 28–September 1, 1967. Barber, R. C. (ed.). Winnipeg, Can., University of Manitoba Press, 1967.
See CONF-670818.

The various methods used for the calculation of the binding energy and saturation of nuclear matter are discussed. It is pointed out that current nuclear matter theory is in disagreement with the semiempirical mass formula. (J.W.R.)

23769 TOWARD A THOMAS–FERMI MASS FORMULA. Myers, William D. (Univ. of California, Berkeley). pp 61-84 of Proceedings of the Third International Conference on Atomic Masses, University of Manitoba, Winnipeg, Canada, August 28–September 1, 1967. Barber, R. C. (ed.). Winnipeg, Can., University of Manitoba Press, 1967.
See CONF-670818.

Nuclear properties, nuclear masses in particular, lend themselves to a two-part approach in which average properties and shell effects are treated separately. Recent improvements in treating the shell-effect part of nuclear masses have stimulated an investigation of corrections to the smooth part of the formula (the liquid-drop-model part). The Thomas-Fermi statistical method is employed to calculate these corrections, and the coefficient of the $A^{1/3}$ term is discussed in detail. In addition the nuclear density distributions are shown which arise in the course of the Thomas-Fermi calculations. (auth)

23770 A MODEL-BASED MASS LAW, AND THE r-PROCESS AS A MASS LAW TEST. Seeger, Philip A. (Los Alamos Scientific Lab., N. Mex.). pp 85-118 of Proceedings of the Third International Conference on Atomic Masses, University of Manitoba, Winnipeg, Canada, August 28–September 1, 1967. Barber, R. C. (ed.). Winnipeg, Can., University of Manitoba Press, 1967.
See CONF-670818.

A mass law is presented, based on the liquid-drop model with shell and deformation corrections given by the Nilsson model and pairing energy by the Bardeen-Cooper-Schrieffer model. The resulting mass law has a total of 10 parameters, including all model parameters, and gives a standard deviation of 0.78 MeV when adjusted to the binding energies of 1127 known nuclei above mass 40. The r-process of nucleosynthesis is discussed and shown to be relatively insensitive to all assumptions except the mass law. Results obtained using various mass laws are compared. (auth)

23771 Q-VALUES DETERMINED FROM RESONANCE REACTIONS AND THE EFFECTS OF THE ATOMIC ELECTRONS. Staub, Hans H. (Univ., Zurich). pp 495-507 of Proceedings of the Third International Conference on Atomic Masses, University of Manitoba, Winnipeg, Canada, August 28–September 1, 1967. Barber, R. C. (ed.). Winnipeg, Can., University of Manitoba Press, 1967.
See CONF-670818.

An improved method for the determination of nuclear reaction Q-values is described. The effect of the electronic charge of the target nuclei on the Q-value is discussed. Measurements are reported for several reactions to illustrate the difference in atomic Q-values and the purely nuclear Q-values. (J.W.R.)

23772 SYSTEMATICS OF COULOMB ENERGIES AND EXCITATION ENERGIES OF ISOBARIC ANALOGUE STATES. Jaenecke, Joachim (Univ. of Michigan, Ann Arbor). pp 583-608 of Proceedings of the Third International Conference on Atomic Masses, University of Manitoba, Winnipeg, Canada, August 28–September 1, 1967. Barber, R. C. (ed.). Winnipeg, Can., University of Manitoba Press, 1967.
See CONF-670818.

The perturbative effects of Coulomb forces in nuclear structure calculations are discussed. Coulomb displacement energies and the A- and T-dependence of the parameters describing isobaric multiplets are examined. (J.W.R.)

23773 SINGLE-PARTICLE AND VIBRATIONAL STATES OF THE ODD-A DEFORMED NUCLEI IN THE RARE-EARTH REGION. Rich, C. W.; Bunker, M. E. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 42-54(1967). (In Russian). (LA-DC-7468).

The lower energy levels of the odd rare-earth elements agree with the states predicted by the Nilsson model and its rotational states. This question was examined by a critical analysis of the available empirical experimental data on the energy states of deformed rare-earth elements, reviewing the identification of the vibrational and one-particle states. The recently obtained high-resolution data of (d,p) and (d,t) nuclear spectroscopy were of great interest to the study. The energy levels of odd-neutron rare-earth elements and the moments of inertia of the odd-proton nuclei were analyzed, deriving conclusions concerning their parity. The study of the vibrational states indicated that the largest intermixing of the one-particle and vibrational states may be expected for states with the same number of K, even if their energies differ by more than 1 MeV. This is attributed to quadrupole-quadrupole interaction which reaches a maximum when the one-particle state and the ground state of the vibrational motion are related by an E2 matrix element, as is the case for the ^{159}Tb and the Yb isotopes. The three quasiparticle components play a dominant role. Most of the <400-500 keV states were found to be very complex; therefore care must be exercised when applying the Nilsson model to states with energies below the lowest vibrational levels. (TTT)

23774 UNDERSTANDING THE COMPOUND NUCLEUS. Weidenmueller, Hans A. (Yale Univ., New Haven. Institut fuer Theoretische Physik, Heidelberg). Comments Nucl. Particle Phys., 3: 16-21(Jan.-Feb. 1969).

The microscopic approach to the description of the compound nucleus in nuclear reactions is discussed. It is shown how specific features such as doorway states and intermediate structure are explained, and it is noted that the compound-nucleus picture and the idea of single-particle motion are not opposites. (J.W.R.)

23775 PRODUCTION OF PI-MESONS BY INELASTIC ELECTRON SCATTERING FROM NUCLEI. Ho-Kim, Q. (Laval Univ., Quebec). Nucl. Phys., A127: 641-51(1969).

The pi-meson contribution to the inelastic electron scattering was investigated. Starting from the general form of the production amplitude, making no specific assumptions about nuclear states, but using the impulse approximation and neglecting final state interactions, a formula was derived for the double coincidence cross section, in which nuclear structure and the emission mechanism are conveniently separated. For numerical calculations the production amplitude for a single nucleon derived in a dispersion approach is used, and an example involving in the final system the collective vibrational states of ^{16}N, which have been the subject of many recent studies, is considered. (auth)

23776 RECOIL OF A NUCLEAR TARGET HIT BY A NUCLEON. Da Providencia, J. (Univ., Coimbra). Nucl. Phys., A127: 525-30(1969).

From considerations of translation and Galilean invariances it is shown that the motion of a nucleon in the relative frame of reference fixed to the center of mass of an A-particle target may be described by a Schroedinger equation which, essentially, differs in one point only from the Hartree–Fock equation determining the independent motion of the target nucleons relative to the lab frame–the kinetic energy term contains the reduced mass $m(1 + A^{-1})^{-1}$ instead of the nucleon mass m. (auth)

23777 EFFECT OF ATOMIC HYPERFINE QUADRUPOLE INTERACTIONS ON THE POLARIZATION OF RECOIL NUCLEI. Wells, John C. Jr.; Madansky, Leon (Johns Hopkins Univ., Baltimore). Nucl. Phys., A127: 673-8(1969).

The effect of atomic hyperfine quadrupole interactions on the polarization of recoil nuclei in a magnetic field is calculated. A dependence on the sign of the nuclear quadrupole moment and on the relative direction of the magnetic field is found. Experiments are proposed to use this effect for measuring nuclear electric quadrupole couplings of β-radioactive nuclei. (auth)

23778 POLYNOMIAL BASES AND WIGNER COEFFICIENTS FOR $SU(3) \supset R_3$. Sharp, R. T. (McGill Univ., Montreal); Von Baeyer, Hans C.; Pieper, S. C. Nucl. Phys., A127: 513-24 (1969).

Polynomial bases for the group $SU(3) \supset R_3$ are derived. Explicit expressions, normalized, are given for all simple states, i.e., those for which L, M are sufficient internal labels. Closed formulas without sums are given for the Wigner coefficients in the following cases: $(p_1, 0) \times (p_2, 0) \rightarrow (p_1 + p_2, 0)$; $(p_1, 0) \times (p_2, 0) \rightarrow (p_1 + p_2 - 2, 1)$; and $(p_1, 1) \times (p_2, 0) \rightarrow (p_1 + p_2, 1)$, where p_1 and p_2 are arbitrary. Symmetries of the Wigner coefficients are discussed. (auth)

23779 ANALYSIS OF TRIPLE $\gamma-\gamma$ ANGULAR CORRELATIONS BY A METHOD OF FORCED CONVERGENCE. Bertini, R. (Institut de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods, 69: 351-2(Apr. 1969). (In French).

A computer analysis of the $\gamma-\gamma$ triple angular correlations measured with the Litherland and Ferguson method I is performed by an iterative method that finds necessarily convergent solutions. (auth)

23780 RADIATIVE CAPTURE FOR INTERMEDIATE-ENERGY NEUTRONS. Longo, G.; Saporetti, F. (Comitato Nazionale Energia Nucleare, Bologna). Nucl. Phys., A127: 503-12(1969).

A systematic analysis is carried out to test the validity of the direct and collective mechanisms for the neutron radiative capture by nuclei in a wide range of mass number. It is found that the two processes can reasonably explain the experimental (n,γ) cross sections of heavy nuclei ($A > 40$) with magic or near-magic neutron number in the 10- to 20-Mev neutron energy range, while in the 5- to 10-Mev energy range, a contribution from the compound-nucleus mechanism is also necessary. The results are obtained by using for all the nuclides the same set of optical and bound-state parameters consistent with experimental data. It is also shown that the dependence of the experimental cross sections on the neutron number N of the target nucleus and on the asymmetry factor $(N-Z)/A$ seems to reveal some shell effects. (auth)

23781 COMPARISON BETWEEN TWO METHODS FOR THE SOLUTION OF THE LANE EQUATIONS. Bondorf, J. P.; Bund, G. W. (Univ. of Washington, Seattle). Nucl. Phys., A127: 481-94(1969).

Scattering amplitudes for elastic proton scattering from the isospin-dependent local Lane potential are calculated by exact numerical integration and in a one-level approximation using the Green function techniques. As an example, scattering from ^{208}Pb is considered around resonances which are analogs of single-particle bound states in ^{209}Pb. Close agreement is found between scattering amplitudes calculated with the two methods. Tables of calculated S-matrix elements, which are useful for checking purposes, are given. The parameters for resonances such as analog resonances are determined from an analytic pole-expansion of the scattering amplitude; this method is particularly useful in combination with the exact numerical integration method. (auth)

23782 NUMERICAL TABLES FOR BETA-DECAY AND ELECTRON CAPTURE. Behrens, H.; Jaenecke, J. Landolt-Boernstein Numerical Data and Functional Relationships in Science and Technology. New Series. Group 1. Nuclear Physics and Technology. Volume 4. Berlin, Heidelberg, and New York, Springer-Verlag, 1969. 322p. DM 118,--; $29.50.

For β decay, a tabulation of certain combinations of the electron radial wave functions and phase shifts for the cases with and without screening is presented. For electron capture, the amplitudes and the values of the electron radial wave function at the nuclear radius are given for the K, L, and M shells for all values of Z. A compilation of all the relevant formulas used in the treatment of β decay and electron capture is included. (D.C.W.)

23783 NUCLEAR PHYSICS. AN INTRODUCTION. Von Buttlar, Haro. New York, Academic Press, Inc., 1968. 556p. $14.50.

Translated from the German by Fernando B. Morinigo.

An introduction to nuclear physics is first presented without using quantum mechanics. A brief introduction to quantum mechanics is then followed by the application of quantum mechanics to nuclear particles. (D.C.W.)

23784 EXPERIMENTAL METHODS FOR THE DETERMINATION OF INTERNAL CONVERSION COEFFICIENTS. Lizurej, Henryk I. (Jagellonian Univ., Krakow). Postepy Fiz., 82: 643-9(1968). (In Polish).

Experimental methods for the determination of internal conversion coefficients are described. (auth)

23785 COLLECTIVE MODELS OF THE NUCLEUS. Davidson, J. P. Pure and Applied Physics. A Series of Monographs and Textbooks. Volume 29. New York, Academic Press, Inc., 1968. 249p. $19.50.

The various collective models are described from a phenomenological point of view. The physics of the liquid drop model, the different classes of nuclei, and the various types of nuclear transitions are discussed. (D.C.W.)

23786 APPLICATION OF THE THEORY OF REDUCED DENSITY MATRICES: AN EMPIRICAL SUM RULE FOR EXCITED NUCLEAR LEVELS. Gadioli-Erba, E.; Sona, P. G. (CISE, Milan. Univ., Milan). Energ. Nucl. (Milan), 16: No. 4, 32-4(Apr. 1969).

An empirical comparison, suggested indirectly by the theory of density matrices, is done between a sum Σ of excitation energies of certain nuclear levels, and the total binding energy B of the nucleus. Differences and similarities with the case of the analogous comparison for the atomic systems are discussed. A correlation between Σ and B is suggested. (auth)

23787 X-RAY YIELDS IN ALPHA-PARTICLE EXCITATION. Brunner, G. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Isotopenpraxis, 4: 455-8(Dec. 1968). (In German).

According to Henneberg's formula, the alpha-particle K-ionization cross sections were calculated for six elements, from carbon to zinc. From this X-ray yields were found, taking into account fluorescence yields and X-ray self-absorption, for a geometry in which exciting source and X-ray detector were on the same side of the target. A very simple formula for calculating the yields including alpha-particle energy and atomic number of the target material only, enables coarse evaluations. (auth)

23788 VALIDITY OF NUCLEAR DEFORMATION ENERGIES OBTAINED FROM SINGLE-PARTICLE LEVELS. Bassichis, W. H. (Massachusetts Inst. of Tech., Cambridge); Wilets, L. Phys. Rev. Lett., 22: 799-802(Apr. 14, 1969).

Several prescriptions have been pursued for approximating the nuclear deformation-energy surface employing single-particle energies and wave functions. Theoretical arguments are presented to demonstrate that such a program can not be valid without utilization of further information about the two-body potential. A numerical test is performed on various approximative schemes; all were found to be substantially in error. (auth)

23789 ANALYSIS OF WIDE, NEAR-THRESHOLD RESONANCES. Sergeev, V. A. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 1680-5(1968). (In Russian).

It has been shown that at sufficiently low energies, the wide, near-threshold resonances may be conveniently identified by means of the complex scattering lengths and the true effective radius which is of the order of the action radius of nuclear forces. Analysis of these resonances makes it possible to determine the energy dependence of the scattering amplitude and to solve thereby the resonance parameters of the formula which determines the isolated level in the R-matrix theory. The same approach was used to examine the next term of the M matrix. The resonance reactions examined included the $^3H(d,n)^4He$ and $^3He(d,p)^4He$; $^6Li(n,t)^4He$; $^{12}C(p,\gamma)^{13}N$ reactions and the resonance scattering of nucleons on ^4He at low energies. In order to simplify the calculations, it was assumed that no Coulomb interaction took place and only one channel of the M matrix was examined. It was found that if the wide, near-threshold parameters are determined, the parameters of the R matrix have an unequivocal value. (TTT)

23790 ORIENTATION OF ATOMIC NUCLEI AT LOW TEMPERATURES. I. STATIC METHODS. Balla, D. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 20: 663-703 (1968). (In Rumanian).

Experiments with oriented nuclei depend strongly on the development of modern techniques to create very low temperatures. The The method was used with success for the study of the nonconservation of parity in weak interactions. A direct coupling between an external field of about 10^5 oersted and a nuclear spin system at about 10^{-2}°K causes a reduction of the entropy of the nuclear spin system at about 20 to 30%. The static methods used studying the orientation of nuclei are based on the determination of the thermal equilibrium distribution of the population at various energy levels. The method is very efficient when very high-intensity, magnetic fields and very low temperatures are used. The very low temperatures are created by the adiabatic demagnetization of magnetic salts. The direct polarization method of Gerter–Rose, Bleaney's method and Pound's technique are reviewed. The physical studies on oriented nuclei include examination of the angular distribution of the γ radiation, directional distribution of the α particles and interaction with slow neutrons. (TTT)

23791 EIGENCHANNEL CALCULATION FOR A SOLUBLE MODEL. Delsanto, P. P. (Univ., Frankfurt am Main. Univ., Cagliari, Italy); Roetter, M. F.; Wahsweiler, H. G. Z. Phys., 222: 67-92(1969).

The accuracy of the eigenchannel method for treating nuclear reactions is examined by a comparison with the exact solution of a problem of two coupled channels. No crucial deviations between the exact and the eigenchannel cross sections are observed. The questions connected with the non-orthogonality of the sets of radial states used in the eigenchannel treatment are also discussed. It is concluded that, in principle, the eigenchannel method is capable of producing the correct shape of nuclear cross sections, without introducing spurious wiggles. (auth)

23792 THE NUCLEAR INDEPENDENT PARTICLE MODEL. THE SHELL AND OPTICAL MODELS. Green, A. E. S.; Sawada, T.; Sacon, D. S. New York, Academic Press, Inc., 1968. 371p. $16.00.

The independent particle model of the nucleus is described with specific consideration of the single-particle shell model and the optical model. The limits of the optical model and the use of velocity-dependent, energy-dependent, and nonlocal nucleon-nucleus potentials are among the topics treated. An up-to-date discussion of N–N interactions and the one boson exchange potential is included. (D.C.W.)

23793 COLLECTIVE MOTION AND INERTIAL MOMENTS OF DEFORMED NUCLEI. Krutov, V. A. Vestn. Leningrad. Univ., No. 16, Ser. Fiz. Khim., No. 3, 24-30(Aug. 1968). (In Russian).

The collective motion in the nucleus is defined as the change of density of nuclear matter with time. Based on this definition the theory of the rotation of deformed nuclei is constructed. It may be applied to the nuclei both with axial and non-axial equilibrium shape. In this model the inertial moments are in good agreement with the experiment. (auth)

23794 FINITE-NUCLEUS G MATRIX IN THE MICROSCOPIC DESCRIPTION OF INELASTIC PROTON SCATTERING. Petrovich, F. (Michigan State Univ., East Lansing); McManus, H.; Madsen, V. A.; Atkinson, J. Phys. Rev. Lett., 22: 895-9 (Apr. 28, 1969).

The Kallio–Kolltveit interaction is used as the effective interaction in a distorted-wave-approximation analysis of a few transitions in the reactions ^{12}C(p,p′) and ^{40}Ca(p,p′) at energies ranging from 25 to 55 MeV, and a comparison is made with results obtained using Yukawa interactions parametrized on the basis of low-energy nucleon-nucleon and nuclear data. It is concluded that the Kallio–Kolltveit interaction gives a good account of the basic features of the reactions, whereas the other interactions considered lead to somewhat poorer overall agreement with experiment. (auth)

23795 THE COLLECTIVE CORRELATION MODEL OF THE GIANT RESONANCE WITH THE SURFACE-DELTA-INTERACTION. Reinhard, Paul-Gerhard; Arenhoevel, Hartmuth (Univ., Frankfurt am Main). Z. Phys., 222: 165-79(1969).

The intermediate structure of the giant resonance of light nuclei (^{12}C, ^{16}O, ^{28}Si, ^{32}S, and ^{40}Ca) was investigated in the model of collective correlations by means of the surface-delta-interaction (SDI). The SDI introduces also a coupling of 1p-1h excitations to the surface vibrations. Despite the simplicity of this model the gross features of the absorption cross sections are quite well resembled. Furthermore, this model predicts a considerable inelastic photon scattering into the first excited 2^+ level. (auth)

23796 SPATIAL STRUCTURE OF ATOMIC NUCLEI. Belgicatom, Ass. Belge Develop. Pac. Energ. At., Bull. Inform., 13: 6-10(Jan.-Mar. 1968). (In French).

A review of the interpretations of Weckering is given. After a review of his interpretation of electron phenomena in terms of fixed positions in nodal fields, new applications of his physical interpretation of quantum numbers in nuclear phenomena are discussed. Analysis of nuclear structure in terms of nodal spherical concentric levels illustrates that the nucleus always possesses a privileged symmetry axis, which may be used to interpret structural features. This effect of the nucleus, in the case of carbon, distorts the bonding from perfect tetrahedral symmetry. Other nuclear influences include oxidation state availability. The concept of magic numbers may be shown to be better organized around two series of numbers, not one. A new interpretation of the neutrino, as a result of proton into neutron within the nucleus and reorganization in the nodal levels, may be made: the neutrino is said to be not a particle, but a wave distinct in type from a γ ray. These proposals should be examined by competent physicists. (BBB)

23797 LOW-ENERGY LEVEL DISTRIBUTIONS OF LIGHT NUCLEI. Gadioli, E.; Recami, E.; Zetta, L. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Nucl. Phys., A128: 339-52(1969).

By following a procedure suggested by Ericson, the cumulative number of low-energy levels of residual nuclei in statistical reactions is analyzed. The analysis shows that the Lang and LeCouteur level density based on the Fermi gas model of the nucleus, with a fixed set of average parameters obtained by analyzing slow neutron resonance spacings, level widths at high excitation energy, energy spectra of particles emitted in statistical reactions, fits with a good accuracy the real level density of light nuclei ($A \leqq 70$) also for very low excitation energies. (auth)

23798 ANGULAR CORRELATION AND LINEAR POLARIZATION MEASUREMENTS ON UNRESOLVED GAMMA-RAY CASCADES. Kajfosz, J. (Nuclear Research Inst., Prague). Czech. J. Phys., 19: 477-81(1969).

A method for the determination of transition multipolarity and neighboring level spins by means of direction- and polarization-correlation measurements on an unresolved mixture of gamma-ray cascades with one common transition is presented. The applicability of this method in particular problems is briefly discussed. (auth)

23799 COMPLEX ANGULAR MOMENTUM APPROACH TO OPTICAL MODEL OF ELASTIC SCATTERING. Mukherjee, Suprokash (Australian National Univ., Canberra); Shastry, C. S. Nucl. Phys., A128: 256-72(1969).

Analytical properties and pology of the partial-wave amplitude for a complex potential with Saxon–Wood radial form are investigated. Various Regge-type representations are studied, and the applicability of the complex angular momentum approach to the optical model of elastic scattering is examined using a set of typical optical-model calculations. (auth)

23800 SOME NUCLEAR MATTER CALCULATIONS. Koehler, H. S. (Rice Univ., Houston, Tex.). Nucl. Phys., A128: 273-93(1969).

The exact method used by Koehler and McCarthy to calculate the reaction matrix for ^{16}O is applied to some nuclear matter calculations with the Hamada–Johnson potential. The method can easily be combined with approximate methods for calculating the reaction matrix which are adequate for some states or when less accuracy is required. The geometric series approximation is extremely good for the $^1S_0$ state, but is less good for the $^3S_1$ state, the error being about 0.05% in the former case and 4% in the latter. For the $^3D_1$ state the approximation fails completely as in the ^{16}O calculations. It is thus desirable to use the exact method to calculate the $^3S_1 - {}^3D_1$ states. For the $^3D_1$ state the second-order expansion as used in the "reference spectrum method" of Bethe, Brandow, and Petschek is also a reasonable approximation. The center-of-mass averaging usually used to approximate the Pauli operator and the energy denominator is quite accurate, giving an error in binding of about 0.1 MeV. The third-order insertion in hole-lines increases the binding by 2 to 4 MeV. The larger value is obtained with a potential spectrum which is attractive for momenta in the region $k_F \to 2k_F$. This makes the wound integral larger, by increasing the long-range correlations. To obtain the effect of the insertion accurately it is thus necessary to calculate the particle spectrum for small excitations, which in turn means carefully calculating the three-body diagrams. Brueckner, Gammel, and Kubis found the third-order insertion increases the binding by about 1 MeV for the BGT potential. The larger result for the Hamada–Johnson potential results from the larger core radius for this potential. When calculating the above insertion, the center-of-mass averaging is again found to be quite accurate. (auth)

23801 BINDING ENERGY AND DENSITY DISTRIBUTION OF FINITE NUCLEI. Donnelly, I. J. (Univ. of Sydney). Nucl. Phys., A128: 129-61(1969).

A single-particle nuclear model and an effective nucleon potential are used to investigate the binding energy and density distribution of finite nuclei. The results for the binding energy are analyzed in the form of the liquid-drop mass formula. It is found that the surface energy coefficient is smaller by 20% for a nucleus of ten nucleons than for large nuclei, the symmetry energy coefficient is constant for all real nuclei, and the surface symmetry energy coefficient is given by $70 [1 \exp(-8I)]$ MeV. The half-density radii of the neutron and proton distributions are equal for stable nuclei, but the neutron surface thickness increases with neutron excess, being some 50% larger than the proton surface thickness for large nuclei. (auth)

23802 RELATIVISTIC HARMONIC OSCILLATOR AND NUCLEAR REACTIONS. Cocho, G.; Flores, J.; Mondragon, A. (Univ. de Mexico, Mexico City). Nucl. Phys., A128: 110-28 (1969).

An algebraic formalism for nuclear collisions is proposed. An analysis of the scattering amplitude is made using the representations of the non-compact U(3,1) group. This is the group of the relativistic harmonic oscillator. The values of the Casimir operator which labels the U(3,1) representation are directly related to the radii of the interacting particles. The matter distributions and spins of the particles are given in terms of the configuration mixing among different U(3) levels. The interaction mechanism is parametrized in terms of the exchange of carriers of U(3,1) quantum numbers. It is shown that the average value of the quantum numbers exchanged may be related to the time delay, and the shape distortion of a cylindrical wave packet. In this way it is possible to give a simple and quantitative criterion for the "directness" of the nuclear reaction. The scattering of spinless particles is discussed in some detail, and the nonrelativistic limit of the expressions is given explicitly. (auth)

23803 APPLICATION OF THE TABAKIN INTERACTION TO THE sd SHELL NUCLEI WITH $36 \leqq A \leqq 39$. Dieperink, A. E. L.; Brussaard, P. J. (Rijksuniversiteit, Utrecht). Nucl. Phys., A128: 34-46(1969).

The Tabakin interaction is applied in a shell-model calculation of sd-shell nuclei with mass numbers $36 \leqq A \leqq 39$. If a slightly modified interaction is used, satisfactory agreement with experiment can be obtained, otherwise the agreement for ^{38}K is poor. Nuclear moments, electromagnetic transition rates, and spectroscopic factors are calculated and are compared to the predictions of the modified surface delta interaction. In general, a reasonable agreement with experiment is obtained from both interactions except for the T = 0 levels in ^{38}K calculated from the modified surface delta interaction. (auth)

23804 ft-VALUES OF SUPERALLOWED $0^+ \rightarrow 0^+$ β-TRANSITIONS AND THE NEUTRON AND PROTON DENSITY DISTRIBUTIONS. Blin-Stoyle, R. J. (Univ. of Sussex, Brighton, Eng.). Phys. Lett., 29B: 12-14(Mar. 31, 1969).

It is shown how second-forbidden corrections to superallowed β-decays can be reliably estimated in terms of the mean square radii of the proton and neutron density distributions in the nuclei concerned. (auth)

23805 THE QUANTUM MECHANICAL EFFECTS ON GAMMA ANGULAR CORRELATIONS FOLLOWING MULTIPLE COULOMB EXCITATION. Smilansky, U. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Lett., 29B: 15-17(Mar. 31, 1969).

The quantum mechanical effects on the gamma angular distribution following multiple Coulomb excitation are investigated in relation to a new method for measuring quadrupole moments of excited states by the reorientation effect. It is shown that in this case the quantal effects might be important, and an estimate of their magnitude is given. (auth)

23806 DYNAMICAL THEORY OF NUCLEAR REACTIONS IN THE FRAMEWORK OF CLUSTER REPRESENTATIONS. Benoehr, H. C. (Univ. of Surrey, Eng.); Wildermuth, K. Nucl. Phys., A128: 1-33(1969).

The Schroedinger equation for the A-nucleon system can be solved approximately by means of the Rayleigh–Schroedinger variational principle. Suitable trial functions for this method can be derived with the aid of cluster representations. From this, a general and unified theory of nuclear bound states and reactions may be formulated. The manner in which the description of the nuclear resonance states, the optical model, and the direct reaction approximations are contained within this theory is discussed. Principal features of resonance theory are studied quantitatively by means of simple examples. (auth)

23807 SYMMETRIC FISSION OF A TWO-PARAMETER LIQUID DROP. Lawrence, James Neville Peed. Nashville, Vanderbilt Univ., 1968. 146p.

Thesis.

A review of fission theory is presented with attention focused on the liquid-drop model. Departing from the trend of describing the contour of the liquid drop by an increasing number of parameters, the present treatment is restricted to only two parameters in order that dynamical calculations may be performed. In order to obtain an indication of the accuracy to be expected in the dynamics, calculations of the fission-barrier energy and other saddle-point properties were made. The electrostatic energy of the uniformly charged drop was computed by a novel and highly accurate method. A technique for locating saddle points is described in detail. The saddle-point properties and corresponding drop shapes are compared with a determination that used nine shape parameters. Agreement is best for fission-ability parameters greater than 0.70. The dynamical equations of motion are derived under the assumptions of incompressibility and irrotational fluid flow. Since the motion of the liquid drop consists of shape changes (and not linear displacement), the two shape parameters are the time-dependent coordinates of the dynamical treatment. An expression for the relative kinetic energy is developed. The equations of motion are expressed in the formalism of the Lagrangian mechanics. Several tests of the theory are proposed. They include small oscillations about the equilibrium configuration and motion from the saddle point to scission. Specific expressions for the equations of motion are developed for a "two-term" velocity potential. Numerical integrations of these expressions describe motions which do satisfy the proposed tests. The success of this treatment of symmetric fission suggests that the method should be extended with the addition of an "asymmetry-shape" parameter to investigate asymmetric fission. (Disser. Abstr.)

23808 QUANTAL CORRECTIONS AND THE WKB APPROXIMATION OF MULTIPLE COULOMB EXCITATION. Alder, K.; Pauli, H. K. A. (Univ., Basel). Nucl. Phys., A128: 193-208 (1969).

For an exact quantal calculation of multiple Coulomb excitation a set of coupled radial differential equations must be solved. The WKB method can be used to facilitate such computations. For large values of the angular momenta the set of coupled radial equations can be approximated by the simpler semiclassical equations. Also for large distances of the projectile from the target nucleus the WKB method simplifies the computation. The earlier suggested symmetrization of the relevant parameters of Coulomb excitation was proved. For the case of the reorientation effect quantal corrections were computed numerically for the excitation probability and the angular distribution of the de-excitation γ rays. The slow convergence of the sum over the orbital momenta in the reaction amplitude can be improved by a method similar to the one used in electron scattering calculations. The numerical computations allow an estimate of the quantal correction for the reorientation effect for all experimental conditions up to a few percent. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstract 21837.

23809 (AI-AEC-12744, pp 139-47) SODIUM CHEMISTRY, FISSION PRODUCT CONTAMINATION. Silberberg, M.; Guon, J.; Zwetzig, G. (Atomics International, Canoga Park, Calif.).

The behavior of fission products released to the coolant in a fast, sodium-cooled, LMFBR reactor during normal operation is reported. A study of corrosion product activities produced by core structure activation by (n,p), (n,α), and (n,2n) reactions are reported including the production of ^{49}Cr, ^{51}Cr, ^{54}Mn, ^{55}Fe, ^{59}Fe, ^{60}Co, ^{58}Co, and ^{57}Ni. The fission product inventory for the Source Term by CURIE code was abandoned in favor of a fission product generation routine specifically designed for the Source Term Program. The isotopes to be considered were limited to those in the fifty most important mass chains. The selected chains were examined in detail and the latest values of half-lives and branching ratios were determined for inclusion in the program input data. Analytical models for treating the various processes affecting fission production distribution in the primary system were developed and reviewed. Among the processes considered are release of fission products to the coolant from the fuel cladding; removal of fission products from the coolant by "plating" on surfaces, trapping, and vaporization; and reintroduction of fission products into coolant by corrosion of plated deposits. Characterization of the Fission Product Behavior Loop was completed and with the exception of the one still unexplained temperature anomaly is a well characterized system. (D.H.M.)

23810 (AI-AEC-12744, pp 149-52) HNPF RETIREMENT. Ureda, B. F. (Atomics International, Canoga Park, Calif.).

Retirement procedures for the HNPF include: spent fuel shipment; activity specification development; excess property disposal; and CPPD activities. (D.C.C.)

23811 (DOCKET-50219-17) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. [Preliminary Safety Analysis Report], Amendment 11. (Jersey Central Power and Light Co., Morristown, N. J.). Sept. 5, 1967. 487p. Dep. CFSTI.

Projected 1986 population distributions around the Oyster Creek Power Reactor, Unit 1 site are shown graphically. Tornado occurrence probabilities and effects are assessed. Effluent diffusion and recirculation studies for Barnegat Bay are detailed; environmental monitoring stations are shown. Heat dissipation rates for the containment system charcoal filters are tabulated. Allowable radioactivity levels in the primary and secondary systems during operation are described. Primary coolant activity levels are extrapolated from Dresden 1 data; assuming these activity levels, a steamline break accident is analyzed. Fumigation conditions, which can occur at the Oyster Creek site, are described. Radiological dose rates are calculated for an assumed fission product release. Kinetic effects of xenon during core lifetime are discussed; reactivity worths are shown as a function of exposure and as a function of time. The physical model used to evaluate stability against xenon-induced power oscillations is described. Operation and effects of the rod worth minimizer are analyzed. The analytical model used for coolant loss accident analyses is detailed; sensitivity of the model is evaluated. Effects of metal-water reactions on containment integrity are assessed. The possibility of containment vessel liner buckling is evaluated. Procedures for preoperational integrity and leak rate tests of the primary system are outlined. Effects of the containment system of pressure-temperature transients during coolant loss accidents are analyzed in detail. Effects of missile generation inside the containment are evaluated; the probability of these missiles penetrating the containment structure is considered. Methods for determining reactor building displacement under seismic loadings are described. Set points for pressure increase, rod withdrawal, and recirculation flow increase and decrease are shown. Frequency response is given for changes in gain and phase margin of various pieces of equipment in the system. Hydrodynamic stability of the core is assessed; transfer functions are shown. Schematics of the control oil system for the turbine generator are included. Calibration data and procedures are given for the low and average power range monitoring instrumentation. Stability of the lowest steady-state power operation is analyzed. Failure mode analyses are given for the reactor and turbine building closed cooling water systems and for the service water system. The startup test program is outlined; the complete radiation emergency plan is included. Initial startup control rod withdrawal is described; the complete preoperational test program sequence is included. (M.L.S.)

23812 (DOCKET-50219-18) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Final Report on Reactor Vessel Repair Program, Amendment 35. (Jersey Central Power and Light Co., Morristown, N. J.). Mar. 25, 1968. 42p. Dep. CFSTI.

Results of the detailed examination of the Oyster Creek Power Reactor, Unit 1 pressure vessel and primary system are summarized. The repair program for the bottom head area of the pressure vessel is detailed. Results of liquid dye penetrant, ultrasonic, and visual inspections are then detailed; the welds examined are listed and shown schematically. A shroud support cone defect map is sketched, also. A complete history, from mill fabrication to site, is given; testing, examination, and inspection are described; some mill data are included. The cause of the weld defect problem and its influence on the rest of the primary system are evaluated. (M.L.S.)

23813 (DOCKET-50219-19) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Supplemental Report [on] Reactor Vessel Repair Program, Amendment 43. (Jersey Central Power and Light Co., Morristown, N. J.). Oct. 21, 1968. 14p. Dep. CFSTI.

Intergranular cracking of the nozzle safe ends in the Oyster Creek Power Reactor, Unit 1 pressure vessel is described. Remedial procedures and scope of repair work are redefined. Results obtained in the thorough check out of the nozzle safe ends is summarized in tabular form. Results of laboratory metallographic analyses of the nozzle safe ends which were replaced are given. (M.L.S.)

23814 (DOCKET-50219-20) OYSTER CREEK NUCLEAR POWER PLANT, [UNIT NO. 1]. Reactor Vessel Repair Program, Amendment 36. (Jersey Central Power and Light Co., Morristown, N. J.). Mar. 27, 1968. 45p. Dep. CFSTI.

The repair procedures for the Oyster Creek Power Reactor, Unit 1 are included. The procedures delineate the technical requirements for vessel repair; the following procedures are detailed: control rod drive penetration stub tube weld repair; field weld replacement; field weld and control rod drive housing removal and reinstallation; in-core flux monitor field weldment; contour grinding of control rod drive penetration shop welds in the field; overlay welds on control rod drive stub tubes; reweld of control rod drive hydraulic lines; blending requirements for repaired areas; repairing arc-strikes on experior surfaces for carbon steel and low alloy steel surfaces; and Inco 182 shop weld to shop cladding interface. (M.L.S.)

23815 (DOCKET-50237-9) DRESDEN NUCLEAR POWER STATION, UNIT 2. VOLUME II. PLANT DESIGN AND ANALYSIS REPORT. (Commonwealth Edison Co., Chicago, Ill.). May 17, 1965. 78p. Dep. CFSTI.

A complete set of engineering drawings, schematics, and graphs for the Dresden Power Reactor, Unit 2 is included. Drawings and illustrations are given for the core and intervals, all systems associated with the reactor, and the site and environs. (M.L.S.)

23816 (DOCKET-50244-17) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Final Facility Description and Safety Analysis Report, Amendment 17, Suppl. 11, Exhibit D-15. (Rochester Gas and Electric Corp., N. Y.). Mar. 20, 1969. 183p. Dep. CFSTI.

Procedures for operation of the Robert E. Ginna Power Reactor, Unit 1, following a hypothetical earthquake, are listed. The thermal shield for the core is described. The analytical model for determining seismic-induced dynamic loadings of the Class I piping systems is given. Effects of post-accident conditions and Emergency Core Cooling Systems (ECCS) solutions on the materials throughout the reactor and associated systems are detailed. Control rod power supply connections and rod groupings are described. Reactor trip set-points which have been assumed for accident analyses are listed; negative reactivity insertion is shown as a function of trip-time for hot-zero-power 105%-coolant-flow conditions. (M.L.S.)

23817 (DOCKET-50245-12) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. [Preliminary] Design and Analysis Report, Vol. 1. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). Nov. 15, 1965. 409p. Dep. CFSTI.

Information on Millstone Point Power Reactor, Unit 1 is given on the following broad topics: Introduction and Summary; Site and Environs; Reactor Design; Reactor Coolant System; Containment Systems; Additional Engineered Safety Features; Radioactive Waste Control Systems; Station Electrical Systems; Station Control and Instrumentation; Reactor Auxiliary and Cooling Systems; Steam and Power Conversion System; Other Station Structures; Conduct of Operations; and Safety and Accident Analyses. (M.L.S.)

23818 (DOCKET-50245-13) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. [Preliminary] Design and Analysis Report, Vol. 2. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). Nov. 15, 1965. 296p. Dep. CFSTI.

A complete set of preliminary engineering drawings are given for the Millstone Point Power Reactor, Unit 1. Drawings are included for all systems of the reactor and associated auxiliary, power and steam conversion systems. Appendices include: a reliability of the reactor protection system, a control rod drive system description and analysis, the jet pump development program, the core spray test program, and the earthquake design criteria. (M.L.S.)

23819 (DOCKET-50296-9) BROWNS FERRY NUCLEAR POWER STATION, UNIT 3. Design and Analysis Report, Amendment 4. (Tennessee Valley Authority, [Knoxville]). Apr. 8, 1968. 35p. Dep. CFSTI.

Maintenance of adequate net positive suction head (NPSH) for the Browns Ferry Power Reactor, Unit 3 Emergency Core Cooling System pumps is described; NPSH availability and margin are shown graphically. Design criteria and parameters, loading requirements and margins, and operation of the diesel-generator system are discussed. The seismic design and analysis of the suppression chamber are outlined. (M.L.S.)

23820 (DOCKET-50301-4) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Vol. 2. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Aug. 3, 1967. 675p. Dep. CFSTI.

Information on Point Beach Power Reactor, Unit 1 is given on the following broad topics: Summary Description; Site and Environment; Reactor; Reactor Coolant System; and Containment System. (M.L.S.)

23821 (DOCKET-50301-5) POINT BEACH NUCLEAR PLANT UNIT NO. 2. Preliminary Facility Description and Safety Analysis Report, Vol. 3. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Aug. 3, 1967. 437p. Dep. CFSTI.

Information on Point Beach Power Reactor, Unit 2 is given on the following broad topics: Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion; Radioactive Wastes and Radiation Protection; Conduct of Operation; Initial Tests and Operation; and Safety Analyses. (M.L.S.)

23822 (DOCKET-50320-11) THREE MILE ISLAND NUCLEAR STATION, UNIT 2. Preliminary Safety Analysis Report, Amendment 7. (Metropolitan Edison Co., Reading, Pa. Jersey Central Power and Light Co., Morristown, N. J.). Mar. 17, 1969. 56p. Dep. CFSTI.

Revised information on the Three Mile Island Power Reactor, Unit 2 is given on: reactivity insertion rates and control rod worths; electrical system design, distribution network and emergency power; loads on the emergency safety features in the event of a coolant loss accident; analyses of effects of uncompensated operating reactivity changes; analysis of bond stress transfer between tendon conduit and the contracting internal and external concrete surfaces; and diesel generator loading to bring the reactor from normal operation at power to cold shutdown in the event of loss of offsite power. The in-service surveillance program for the cooling systems is given. Reactor containment building surveillance is discussed. (M.L.S.)

23823 (DOCKET-50321-8) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Preliminary Safety Analysis Report, Amendment 4. (Georgia Power Co., Atlanta). Mar. 24, 1969. 200p. Dep. CFSTI.

Design changes in the core and fuel elements for the Edwin I. Hatch Power Reactor, Unit 1 are detailed. The reactor and associated auxiliary cooling systems are described; test temperature requirements for the pipes are tabulated. Cooling system inspection and testing are discussed; an examination schedule is given. Primary system safety relief valves are described; safety valve actuation and malfunction are discussed. The reactor coolant pressure boundary is shown schematically; results of safety valve sizing analyses are presented graphically. Primary system leak detection methods are described. The residual heat removal system and autorelief system are detailed. Design parameters for the standby liquid control system are tabulated; system functions are delineated; system performance is analyzed. Calibration, inspection, and testing of the rod block monitoring subsystem are outlined. Justifications for reliance on a fixed setting flux scram level and no inclusion of a flow variable scram feature are presented. The on-line process computer is described. Instrumentation and controls for the solid, liquid, and gaseous radwaste systems are detailed; typical radioactivities are tabulated for the three systems. The design and operation of the reactor core isolation cooling system are described. Class I and Class II structures and systems are defined; seismic analysis procedures are given for each system. (M.L.S.)

23824 (DOCKET-50334-4) BEAVER VALLEY POWER STATION. [Preliminary Safety Analysis Report], Amendment 1. (Duquesne Light Co., Pittsburgh, Pa.). Mar. 21, 1969. 285p. Dep. CFSTI.

Revised information on Beaver Valley Power Reactor is given for the following sections of the Preliminary Safety Analysis Report: Introduction and Summary; Site; Reactor; Reactor Coolant System; Containment System; Engineered Safety Features; Instrumentation and Control Systems; Emergency and Auxiliary Systems; Radiation Protection and Waste Disposal Systems; and Safety Analyses. Additional information on seismic design is given, also. (M.L.S.)

23825 (GAMD-8743) POSTIRRADIATION EXAMINATION OF PEACH BOTTOM FUEL ELEMENTS E05-05 AND C05-05, AND RELATED ANALYSIS. Busch, D. D.; Carpenter, F. D.; Dahlberg, R. C.; Disselhorst, B. F.; Guggisberg, D. G.; Harmon, D. P.; Kantor, M. E.; Scheffel, W. J. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 17, 1969. Contract AT(04-3)-314. 137p. Dep. CFSTI.

Design parameters for Peach Bottom Power Reactor Unit 1 fuel elements are presented. Fabrication procedures for the fuel elements are described. Results of postirradiation examination of fuel elements E05-05 and C05-05 are presented. (D.C.C.)

23826 (GEAP-5751) POWER REACTOR HIGH PERFORMANCE UO_2 PROGRAM. Progress Report Number 8, July 1–September 30, 1968. Ogawa, S. Y. (comp.) (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Oct. 1968. Contract AT(04-3)-189. 45p. (EURAEC-2095). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Operations at the Big Rock Point Power Reactor during July to September 1968 are described. Postirradiation examination results for fuel assemblies D-50 to D-55 are presented. (D.C.C.)

23827 (NP-tr-1740) THE CONTROL OF THE OBRIGHEIM NUCLEAR POWER STATION. Aleite, Werner; Lepie, Guenther; Rauscher, Theodor. Translated from At. Strom, 13: No. 11-12, 194-8(Nov.-Dec. 1967). 17p. Dep.

The functions of the most important regulating devices of the nuclear power station are described. Special emphasis is placed on the reactor regulating and control devices. When discussing regulating systems conventionally used in thermal power stations, attention is drawn to the special design aspects affecting operations in a nuclear power station. (auth)

23828 (WAPD-MRP-127) PRESSURIZED WATER REACTOR (PWR) PROJECT. Technical Progress Report, October 26, 1968–January 24, 1969. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT(11-1)-Gen-14. 22p. Dep. CFSTI.

The refueling procedures for the Shippingport Pressurized-Water Reactor Core 2 Seed 1 and Seed 2 transfer are described. Core 2 design parameters are listed. (D.C.C.)

23829 HEAVY WATER EXPERIENCE AT HALDEN. Wood, J. I.; Wullum, T. (OECD Halden Reactor Project, Norway). Nucl. Eng. Int., 14: 338-42(Apr. 1969).

Experience with heavy water losses, leak detection methods and heavy water degradation gained at the Halden Reactor is reviewed. It shows that the D_2O losses and degradation can be maintained within acceptable limits provided that effective means for detection and location of leakages are available. (auth) (UK)

23830 REVIEW OF EXPERIENCE WITH GAS-COOLED REACTORS. Moore, R. V. Atom, No. 147, 6-22(Jan. 1969).

The development of world-wide gas-cooled power reactors is reviewed. A list of operating gas-cooled power reactors is presented which includes: power capacities, startup dates, load factors, and performances. The performances of various components in gas-cooled power reactors are described.

23831 STEAM GENERATORS OF A 300-MW NUCLEAR POWER STATION HAVE TUBES AND TUBULAR PLATES MADE OF A HIGH NICKEL CONTENT ALLOY. Belgicatom, Ass. Belge Develop. Pac. Energ. At., Bull., 12: 36(July-Oct. 1967). (In French).

Two steam generators operating at 300°C at 145 bars were constructed using the Ni alloy 600 for the tubes and a similar alloy for the plating of some of the tubular plates. These will be used in the Obrigheim power station. This alloy is a Ni–Cr–Fe alloy containing 76% Ni chosen for its resistance to corrosion and its high elastic limit at high temperatures. The generators, each forming part of the coolant circuits, are of the vertical type and carry 90,000 m of 22 mm tubes, giving a heating surface of 5500 m^2 and producing steam at 265° under 50 bars. Tubular plates of ordinary forged steel are plated on the primary circuit side with 12 mm of alloy produced by hard-surface welding. The deposit was made in three layers with relaxation of strains after the first layer. (BBB)

23832 STARTUP EXPERIENCE WITH GKN, KWL, AND KWO NUCLEAR POWER PLANTS. Fraude, A. (EURATOM, Brussels). Atomwirt. Atomtech., 14: 185-6(Apr. 1969). (In German).

Construction of the Dodewaard (GKN), Lingen (KWL), and Obrigheim (KWO) Power Reactors is summarized. Preoperational and startup performance of various components for the Lingen and Obrigheim Power Reactors is discussed. (M.L.S.)

23833 THE GERMAN NUCLEAR POWER PLANT PROJECT: AN "ATOMWIRTSCHAFT" REPORT. Atomwirt. Atomtech., 14: 171-3(Apr. 1969). (In German).

A survey of the German nuclear power plant projects which are in either the planning stages on near completion is given. The growth of nuclear power capacity is tabulated through 1977 when the Baden Nord plant is scheduled to go on line. Planning schedules are given for Lauffen (KKL), Arge 1 Nord, Biblis, Westfalen, THTR, Norddentschland, Salzgitter, Bayern, CHW/VEW, BASF, SNR, and Baden-Nord. (M.L.S.)

23834 NUCLEAR POWER PLANTS IN WEST GERMANY: POSITION, PROSPECTS, AND SCOPE PROBLEMS. Finke, W. Atomwirt. Atomtech., 14: 166-70(Apr. 1969). (In German).

The present status of nuclear power plants in the German Federal Republic is reviewed; predictions are made for future net installed power. The power plants which are either in operation or in planning stages are tabulated. Political, commercial, and technical aspects are considered. (M.L.S.)

23835 INAUGURATION OF LINGEN NUCLEAR POWER STATION. At. Strom., 15: 13-15(Jan. 1969). (In German).

Dedication ceremonies for the Lingen Power Reactor are described. (auth)

23836 THE STADE 660 MW NUCLEAR POWER STATION, ONE YEAR AFTER COMMENCEMENT OF CONSTRUCTION. Sparhuber, Richard (Siemens AG, Erlangen, Ger.). At. Strom., 15: 1-6(Jan. 1969). (In German).

After a short description of the technical construction of the installation a report is given on the stage reached in the work on site in January 1969. The buildings have been erected up to a considerable height above ground; the first constructional stage of the steel sheath is completed. All the main contracts for the mechanical components have been awarded; considerable progress has already been made toward the completion of those parts of the installation which are important for complying with the completion date. (auth)

23837 TAILORED MOVING EQUIPMENT SPEEDS WORK AT PALISADES NUCLEAR PLANT. Power Eng., 73: No. 4, 26-30 (Apr. 1969).

Equipment designed for the unloading of heavy nuclear components from barges at the Consumers Power Co.'s Palisades nuclear power plant in Michigan is described. To hold down construction and handling costs, Bigge Crane and Rigging Co. engineered and built mobile heavy-lift equipment specifically for the Palisades job. A step-by-step photographic report on how the project was carried out is presented. (auth)

23838 SAFER NUCLEAR PLANTS. Addison, J. V. Power Eng., 73: No. 4, 48-50(Apr. 1969).

A description of safety standards and safety evaluation parameters for nuclear power plants is presented. The effects of economics and reactor type on safety evaluation are described. Systems engineering methods for safety evaluation are analyzed. (D.C.C.)

23839 DESIGN AND CONSTRUCTION OF THE OYSTER CREEK CONTAINMENT. Archer, J. C. (Burns and Roe, Inc., Oradell, N. J.); Brown, T. O. Nucl. Eng. Design, 9: 258-64 (Feb. 1969).

A description of the structural design and construction of the pressure suppression type primary containment system and the low pressure secondary containment system for the boiling water reactor of the Oyster Creek Nuclear Power Station is given. The primary containment consists of a field erected steel drywell of light bulb shape and a torus shaped pressure suppression chamber which are inter-connected by ten vent pipes. The secondary containment structure, the reactor building, is of reinforced concrete construction with a top enclosure of metal panels on a structural steel frame. 5 references. (auth)

23840 TRANSITIONAL PERIOD ECONOMICS OF ATOMIC POWER PLANT OPERATION. Batov, V. V.; Koryakin, Yu. I.; Pushkarev, V. I.; Smirnov, V. G. At. Energ. (USSR), 26: 223-7(Mar. 1969). (In Russian).

Economical aspects of the initial stage of an atomic power plant operation are considered from the moment the reactor is commissioned until the stationary pattern of partial refueling is reached. From nuclear physics and technological view-points various types of initial fuel charges and transitional periods that differ from one another by initial excess reactivity compensation adopted may be suggested for the same plant. The effective (correlated) expenses method proposed allows analysis of the transitional period economics and the most profitable type of initial fuel charge. This kind of analysis is especially important for large power plants. 7 references. (auth)

23841 THE IRRADIATED BALL FLUX SCANNING SYSTEM FOR DUNGENESS B. Smith, K. R. E.; Stockdale, D. E.; Cranfield, R. F. pp 68-76 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The development of the Ball Flux Scanning System was derived from the need to overcome the basic mechanical and installation problems which have been associated with the wire system and which are briefly described; at the same time, however, it was desirable to retain the overall accuracy obtained from the wire system. The ball system is based on the simple technique of pneumatically propelling columns of small diameter stainless steel balls through tubes passing from a store situated outside the pressure containment through the reactor vessel to vertical measuring channels. The ball columns are held in position by gas flow for the period of irradiation and then ejected back through the tube to the store. Measurement is made by passing each ball column through an annular ion chamber at a controlled rate using a ball metering device. By scanning the column and relating the distance at which measurement is made against the activity measured, the flux pattern is obtained in the same way as when using wire. The fact that the ball columns are held in position by gas flow enables the system to be suitable for entry into the reactor from any position. (auth)(UK)

23842 POWER STATIONS OF EUROPE. VOLUME 1. FEDERAL REPUBLIC OF GERMANY. Schulte, Richard. Berlin, Verlag A. F. Koska, 1967. 391p. (In German and English).

A review of the electric power demands and potentials in Germany is presented. The economics of fossil fuel power plants, hydroelectric plants, and nuclear power plants are compared. Descriptions of all the power plants in Germany are presented. (D.C.C.)

23843 RESULTS OF RADIATION MEASUREMENTS IN THE CONCRETE SHIELD OF THE GUNDREMMINGEN NUCLEAR POWER PLANT IN THE SPRING OF 1967. Schultz, H. (Technische Univ., Hanover). pp 73-123 of Probleme des Bautechnischen Strahlenschutzes. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).

From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

The instrumentation and procedures used in radiation measurements on the Gundremmingen concrete shield are described, and gamma and neutron flux distributions obtained in the measurements are presented. Results of the measurements are compared to MAC–RAD removal-diffusion calculations. (H.D.R.)

23844 STANDARDIZED NUCLEAR STEAM GENERATORS COME OFF THE LINE. Power Eng., 73: No. 4, 54(Apr. 1969).

A description of assembly-line production of standardized steam generators for nuclear power plants is presented. (D.C.C.)

23845 POWER STATIONS OF EUROPE. VOLUME 2. AUSTRIA. Weiss, Ludwig. Berlin, Verlag A. F. Koska, 1967. 340p. (In German and English).

A review of the electric power demands and potentials in Austria is presented. The economics of fossil fuel plants, hydroelectric plants, and nuclear power plants are compared. Descriptions of all the power plants in Austria are presented. (D.C.C.)

23846 NUCLEAR ENERGY IN CANADA: PRESENT CONDITIONS AND PROSPECTS. Casa, A. F.; Perilli, M. L.; Sansone, M. Com. Naz. Energ. Nucl., Notiz., 14: No. 12, 65-91 (Dec. 1968). (In Italian).

A comprehensive review is presented of the state and prospects of nuclear energy in Canada. Technical and economic data are supplied on the major plants now in operation or under construction: the 20-MW(e) Rolton Reactor in operation since 1962; the Douglas Point Candu PHW 200 in operation since 1967; the Pickering Power Plant with two PHW 500 reactors scheduled to go into operation in 1970 and 1971; the Gentilly BLW plant due to go into service in 1971 and the new Ontario Hydro projects. The mining activities, at present in a phase of substantial development, are discussed in detail. As regards the production of heavy water, of basic importance for Canada's nuclear program, the Glass Bay and Port Hawkersbury plants are described. The fabrication of nuclear fuel is connected with the D_2O reactor development plan, and therefore the various types of fuels developed or being developed in Canada are given close consideration. (24 references) (auth)

23847 OPINIONS ON NUCLEAR PLANT ECONOMICS IN THE USA. Com. Naz. Energ. Nucl., Notiz., 14: No. 12, 92-4 (Dec. 1968). (In Italian).

The opinions, particularly of an economic nature, expressed by certain members of the U. S. nuclear industry, and in the results of a Bechtel study on the possibility of economically operating in the U. S. an AGR-type plant are presented. (auth)

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Refer also to abstract 23991.

23848 (ANL-7553) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, FEBRUARY 1969. (Argonne National Lab., Ill.). Mar. 25, 1969. Contract W-31-109-eng-38. 129p. Dep. CFSTI.

Highlights of project activities are summarized for the month of February 1969. Fuel and components development programs for the LMFBR are described. Operations for the ZPR-3 and ZPPR during February are described. Research and development programs in the EBR-2 are reviewed. Nuclear safety studies, including TREAT operations, and chemical separation activities are discussed. (D.C.C.)

23849 (BNWL-359) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT FOR NOVEMBER 1966. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 103p. Dep. CFSTI.

Highlights of project activities are summarized for the month of November 1966. Areas of development work include: civilian power reactors; applied and reactor physics; reactor fuels and materials; engineering development; plutonium utilization program; and nuclear safety. (D.C.C.)

23850 (BNWL-369) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT FOR DECEMBER 1966. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1967. Contract AT(45-1)-1830. 98p. Dep. CFSTI.

Highlights of project activities are summarized for the month of December 1966. Areas of development work include: civilian power reactors; applied and reactor physics; reactor fuels and materials; engineering development; plutonium utilization program; and nuclear safety. (D.C.C.)

23851 (BNWL-375) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT FOR JANUARY 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1967. Contract AT(45-1)-1830. 104p. Dep. CFSTI.

Highlights of project activities are summarized for the month of January 1967. Areas of development work include: civilian power reactors; applied and reactor physics; reactor fuels and materials; engineering development; plutonium utilization program; and nuclear safety. (D.C.C.)

23852 (BNWL-404) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT FOR FEBRUARY 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1967. Contract AT(45-1)-1830. 119p. Dep. CFSTI.

Highlights of project activities are summarized for the month of February 1967. Areas of development work include: civilian power reactors; applied and reactor physics; reactor fuels and materials; engineering development; plutonium utilization program; and nuclear safety. (D.C.C.)

23853 (BNWL-425) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT FOR MARCH 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1967. Contract AT(45-1)-1830. 107p. Dep. CFSTI.

Highlights of project activities are summarized for the month of March 1967. Areas of development work include: civilian power reactors; applied and reactor physics; reactor fuels and materials; engineering development; plutonium utilization program; and nuclear safety. (D.C.C.)

23854 (BNWL-444) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT FOR APRIL 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 130p. Dep. CFSTI.

Highlights of project activities are summarized for the month of April 1967. Areas of development work include: civilian power reactors; applied and reactor physics; reactor fuels and materials; engineering development; plutonium utilization program; and nuclear safety. (D.C.C.)

23855 (BNWL-468) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT FOR MAY 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 106p. Dep. CFSTI.

Highlights of project activities are summarized for the month of May 1967. Areas of development work include: civilian power reactors; applied and reactor physics; reactor fuels and materials; engineering development; plutonium utilization program; and nuclear safety. (D.C.C.)

23856 (BNWL-499) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT FOR JUNE 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1967. Contract AT(45-1)-1830. 117p. Dep. CFSTI.

Highlights of project activities are summarized for the month of June 1967. Areas of development work include: civilian power reactors; applied and reactor physics; reactor fuels and materials; engineering development; plutonium utilization program; and nuclear safety. (D.C.C.)

23857 (EUR-4211) MAIN CODES DEVELOPED WITHIN THE ORGEL PROJECT REACTOR DESIGN. Jamet, M. F. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec. 1968. 104p. (In French). Dep.

The digital computer programs used for designing the ORGEL Reactor and ORGEL-type reactors are described. (auth)

23858 (NP-tr-1756) THE KARLSRUHE MULTI-PURPOSE RESEARCH REACTOR. Ziegler, A. Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from Atomwirtschaft, 7: 17-26(1962). 28p. Dep.

The 50 MW(e) multi-purpose research reactor MZFR is an installation designed to meet the requirements of reactor development in the Federal Republic. The reactor combines the features of a prototype and a testing reactor. As a prototype it is the first step towards the building of heavy water moderated pressurized reactors. As a testing reactor it offers irradiation and testing possibilities, especially for fuel elements in combination with different coolants. Design parameters and the buildings and facilities are described. (auth)

23859 INDUSTRIAL ASPECTS OF A PROGRAM OF FAST BREEDER REACTORS. Berg, Serge (Nuclelec, Brussels). Belgicatom, Ass. Belge Develop. Pac. Energ. At., Bull., 12: 15-18(May-June 1967). (In French).

Fast breeder development in Europe is reviewed for countries with general exploratory programs (Austria), countries at the small fast reactor design stage (Sweden, Italy), and countries with advanced programs (United Kingdom, France, Germany, Netherlands, and Belgium). (BBB)

23860 THE MORE PRECISE FUTURE OF SODIUM COOLED BREEDERS. Haefele, W. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt. Atomtech., 14: 174-6(Apr. 1969). (In German).

The conservative design philosophy behind the planning and development of the first German sodium cooled reactor is described; some typical fast sodium cooled breeder reactor parameters are tabulated. The short term development potential of the sodium cooled reactor is evaluated; reasons for development and reactor uses are listed. (M.L.S.)

23861 DEVELOPMENT OF STEAM-COOLED FAST BREEDERS. Ritz, L. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt. Atomtech., 14: 200-2(Apr. 1969). (In German).

Development of steam cooled fast breeders is compared with sodium cooled fast breeders. Costs/Kwh and investment costs are tabulated. Development of steam cooled fast breeder fuels and components is discussed; possibilities are evaluated. (M.L.S.)

23862 DEVELOPMENT OF STEAM-COOLED FAST BREEDERS. Kornbichler, H. Atomwirt. Atomtech., 14: 197-200(Apr. 1969). (In German).

The roles of the research groups and industry in the development of steam cooled fast reactors in Germany is reviewed; short summaries of results of component development for the steam breeders are listed. The technological experience gained from eleven years of steam breeder development work is summarized. Consequences of the changes over this time period are evaluated. (M.L.S.)

23863 DEVELOPMENT OF STEAM-COOLED FAST BREEDERS. Haefele, W. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt. Atomtech., 14: 190-7(Apr. 1969). (In German).

A brief idea of the fast reactor concept is given; characteristics distinguishing the fast reactor from the intermediate and thermal reactor-types are delineated. The Karlsruhe fast breeder project is outlined from its inception to the present; the EURATOM fast breeder project is, then, described. Costs of the steam cooled fast breeder reactor development program are tabulated. The serious problems encountered in the development of the steam breeders are listed and discussed. Overall cost breakdowns are compared for development of steam cooled and sodium cooled fast breeders. The very recent (around March 1969) decisions made at the Karlsruhe Nuclear Research Center regarding the fast breeder development programs are detailed. (M.L.S.)

23864 THE MORE PRECISE FUTURE OF HIGH-TEMPERATURE REACTORS. Schulten, R. (Kernforschungsanlage, Juelich, Ger.). Atomwirt. Atomtech., 14: 176-7(Apr. 1969). (In German).

The development of the high temperature gas cooled reactor is outlined. The commercial and safety aspects of this type of reactor, which uses the associated helium turbine, are discussed. High temperature reactor projects in Germany, which include the AVR and THTR, are described briefly; the high-temperature gas-cooled-reactor fuels development and processing program is considered. (M.L.S.)

23865 POSSIBLE FUTURE DEVELOPMENTS OF THE NUCLEAR INDUSTRY IN WEST GERMANY. Kraemer, H. (Kernforschungsanlage, Juelich, Ger.); Seetzen, J. Atomwirt. Atomtech., 14: 218-20(Apr. 1969). (In German).

Criteria are listed for the selection of reactor concepts for future development. Use of systems of combined types of power plants, e.g., conventional plant-light water reactors-fast breeder reactor, is analyzed; work load contributions are shown for each type of plant in the overall system. Combined systems are discussed; advantages of this type of power system are listed. (M.L.S.)

23866 DEVELOPMENT OF GAS-COOLED FAST BREEDERS. Wirtz, K. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt. Atomtech., 14: 216-18(Apr. 1969). (In German).

The general organization of the fast breeder research program is discussed. Efforts in the area of gas cooled fast breeder development is summarized. (M.L.S.)

23867 DEVELOPMENT OF SODIUM-COOLED FAST BREEDERS. Haefele, W. (Kernforschungzentrum, Karlsruhe, Ger.). Atomwirt. Atomtech., 14: 212-16(Apr. 1969). (In German).

The overall development of sodium cooled fast breeder reactors is discussed. The problems associated with development of the sodium cooled fast breeder are outlined. Fuel element development is discussed; radiation histories of oxide fuels are tabulated. The objectives and monetary investment in the SEFOR and KNK reactor projects are reviewed. The international efforts toward sodium cooled fast breeder development are summarized; reactors which are either in the planning or construction stages are tabulated by country. (M.L.S.)

23868 PRESENT TRENDS IN EUROPEAN NUCLEAR INDUSTRY. Kruys, Pierre (EURATOM, Brussels). 9p. of International Nuclear Power Day. Sandviken, Sweden, Sandvik Steel Works, 1968.

From Conference on International Nuclear Power Day, Sandviken, Sweden. See CONF-681124.

A review of nuclear power reactor development in Belgium, France, Germany, Italy, and the Netherlands is presented. A brief discussion on European fuel fabrication potentials is included. (D.C.C.)

23869 PROCESS FOR CONSTRUCTING A NUCLEAR REACTOR STACK. Boutin, Claude; Rappeneau, Jean (to Commissariat a l'Energie Atomique). British Patent 1,149,421. Apr. 23, 1969. Priority date May 12, 1965, France.

GRAPHITE—fabrication of drum and heat treated bars of
REACTORS, GRAPHITE-MODERATED—core for, fabrication of drawn grid heat treated bars for (D.C.C.)

23870 A METHOD OF AND APPARATUS FOR CONVERTING NUCLEAR ENERGY INTO MECHANICAL ENERGY. Wikdahl, Nils Anders Lennart. British Patent 1,149,070. Apr. 16, 1969. Priority date Dec. 9, 1965, Sweden.

REACTORS, POWER—core-turbines for superheating, description of closed loop dual purpose in-core
REACTORS, SUPERHEATING—core-turbine for power, description of closed loop dual purpose
TURBINES—description of closed loop superheating power reactor dual purpose in-core (D.C.C.)

23871 CHANGING ASPECTS OF ELECTRIC POWER SUPPLY. Grafstroem, Erik (Swedish State Power Board, Stockholm). 15p. of International Nuclear Power Day. Sandviken, Sweden, Sandvik Steel Works, 1968.

From Conference on International Nuclear Power Day, Sandviken, Sweden. See CONF-681124.

A review of the growth of nuclear power in Sweden is presented. Predicted power requirements and nuclear power potentials are listed. Economic parameters for large nuclear power plants are analyzed. Comparisons of predicted nuclear power growth are presented for France, Sweden, U. K., and U. S. A. (D.C.C.)

23872 INTERNATIONAL NUCLEAR POWER DAY. Conference held in Sandviken, Sweden, November 28, 1968. Lectures and Discussion. Sandviken, Sweden, Sandvik Steel Works, 1968. 78p. (CONF-681124).

Five papers given during the International Nuclear Power Conference held at Sandviken, Sweden, Nov. 28, 1968 on electrical power demands, the European nuclear industry, the future of plutonium as a nuclear fuel, and materials problems associated with nuclear power generation are presented. Separate abstracts were prepared for each. (L.C.L.)

For abstracts of individual papers see: 22457, 22548, 23868, 23871, and 23921.

23873 NUCLEAR REACTORS. Tyrrell, Joseph Francis (to English Electric Co., Ltd.). British Patent 1,149,245. Apr. 16, 1969. Filed Sept. 28, 1965.

Reference is made to nuclear reactors having a pressure vessel containing a graphite moderator structure which includes multiple columns of graphite bricks. Some of the columns are formed with longitudinal fuel channels. Preloading means are provided to oppose forces conducive to bowing. The moderator structure includes fuel-containing sleeve assemblies arranged longitudinally in the fuel channels. The preloading means is arranged to apply endwise compressive force directly to the sleeve assemblies. The preloading means may also be arranged to apply endwise compressive force directly to at least some of the graphite columns. The preloading means may take the form of spring assemblies, means for applying a pressurized fluid from an external source, or dead weights. Various graphite moderator structures incorporating these features are described. (UK)

Kinetics and Dynamics

Refer also to abstract 23946.

23874 (AI-AEC-12744, pp 27-9) BASIC-THEORY CALCULATION: MONTE CARLO METHODS. Levitt, L. B.; Spanier, J. (Atomics International, Canoga Park, Calif.).

A fast reactor Monte Carlo code entitled VIM is described. The program, when completed, will require a large computer storage facility such as an IBM 360/75 or a CDC 6600. (D.C.C.)

23875 (BAW-3867-6) FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT. Quarterly Technical Report, October–December 1968. Tilford, J. M.; Stewart, J. E.; Colpo, P. N. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Mar. 1969. Contract AT(30-1)-3867. 36p. Dep. CFSTI.

Development of the FARED design code is described. Descriptions of the EXEC control overlay program are INPUT, REGA; and RAIM primary overlays are presented. Burnup calculations are presented for: total fission product reactivity worth at the beginning and end of fuel cycle; Na void decrement at cycle beginning and end; isothermal Doppler coefficients at cycle beginning and end; and power peak-to-average values at cycle beginning and end. 4 references. (D.C.C.)

23876 (EUR-4205) COMPARISON OF HETEROGENEOUS AND HOMOGENEOUS METHODS USED IN THE CALCULATIONS OF ORGEL REACTORS. Decressin, A.; Ligou, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec. 1968. 34p. (In French). Dep.

The knowledge of flux distributions in a power reactor is of very great practical interest. Therefore, in the frame of the conceptual design of an Orgel Prototype several calculation methods have been compared, principally TRIHET and EQUIPOISE. The differences initially stated between the two methods have led to enlarging the domain of the studies. Concerning the application of homogeneous and heterogeneous codes general conclusions could be derived from the various examples presented. 17 references. (auth)

23877 A NON-LINEAR DIGITAL COMPUTER MODEL REQUIRING SHORT COMPUTATION TIME FOR STUDIES CONCERNING THE HYDRODYNAMICS OF BOILING WATER REACTORS. Reisch, Frigyes (Aktiebolaget Atomenergi, Stockholm); Vayssier, George. Nucl. Eng. Design, 9: 196-210(Feb. 1969).

This non-linear model serves as one of the blocks in a series of codes to study the transient behavior of BWR or PWR type reactors. This program is intended to represent the hydrodynamics of the BWR core or of the secondary side of the PWR heat exchanger. The equations have been prepared to use the CSMP digital simulation language. By the most suitable integration routine available, the ratio of simulation time to real time is about one on an IBM 360/75 digital computer. Use of the slightly different language DSL/40 on an IBM 7044 computer takes about four times more. The code has been tested against the Eindhoven loop, with satisfactory agreement. 8 references. (auth)

Control Systems

Refer also to abstract 22033.

23878 (ANL-7530) OPTIMAL DIGITAL COMPUTER CONTROL OF NUCLEAR REACTORS. Lipinski, Walter C. (Argonne National Lab., Ill.). Jan. 1969. Contract W-31-109-eng-38. 255p. Dep. CFSTI.

Thesis. Submitted to Illinois Inst. of Tech., Chicago.

Research undertaken with the objective of applying modern control theory to the analysis and design of an optimal control system for reactors is described. The optimal regulator control law is determined, and the states of the nonlinear deterministic system model are estimated. A consequence of applying dynamic programming to obtain the feedback regulator solution and iteration to the estimation problem is the requirement that a digital computer be used to implement the control and estimation functions. A comprehensive literature survey of earlier applications of modern control theory to nuclear reactors, a detailed review of pertinent reactor kinetics equations, and a compilation of selected nuclear and control engineering bibliographies are included. (H.D.R.)

23879 APPLICATION OF EFFECTIVE BOUNDARY CONDITIONS TO B_4C CLUSTER CONTROL CALCULATIONS. Boerresen, S. (Institutt for Atomenergi, Kjeller, Norway). Nukleonik, 12: 124-9(Mar. 1969).

The validity of the general theory of effective boundary conditions as applied to cylindrical B_4C absorbers was investigated. The absorbers were closely spaced as would be the case in an actual cluster control design. For the thermal energy range, comparison with more accurate computer calculations was performed. A series of critical experiments, involving completely inserted absorber elements, was analyzed. The results were very encouraging since, for a total of 12 cases investigated, the average relative error of the predicted reactivity worth of the absorbers was only 0.23%. The largest relative error observed was 4.38%. 11 references. (auth)

23880 NUCLEAR REACTORS REACTIVITY CONTROL PROCESS. Maldague, P.; Marechal, J.; Lamproye, F. (to Societe Anglo Belge Vulcain SA). Canadian Patent 801,290. Dec. 10, 1968. Priority date Aug. 27, 1964, Luxembourg.

An alternative to ion exchangers as a means of regenerating volatile neutron absorbing substances circulated in a reactor core is proposed. A portion of a substance such as boric acid is subjected to distillation. Resultant vapors are washed in a column by counter current flow. The liquid from the column which is charged with neutron absorbing substances is collected in an intermediate chamber. A first fraction may be recycled to the boiler while a second fraction traverses another circuit. With the aid of valves the amount of boric acid in the core may be adjusted so that with ^{135}Xe, the reactor may be controlled for various power levels or while shut down. Examples of five control problem conditions are discussed. (F.S.A.) (Canada)

23881 REACTOR CONTROL NEUTRON DETECTORS FOR OPERATION AT HIGH TEMPERATURES. Goodings, A.; Hagger, D.; Phillips, R. D. (Atomic Energy Establishment, Winfrith, Eng.). pp 37-43 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The development of concrete pressure vessel gas cooled power reactors and of high power fast reactors has led to a demand for a new generation of reactor control neutron detectors. These devices are necessary because it is no longer possible to find cool, atmospheric pressure sites in which to position more conventional instruments, and they are characterized by their ability to function in high ambient temperatures and pressures and in difficult radiation environments. Design and development work has led to the adoption of three basic devices; a so-called $^{15}/_{16}$" pulse fission chamber (Type P7), a wide range gamma compensated boron chamber (Type DC12), and a dc fission chamber (Type DC14). All three designs will operate at up to 550°C and are equipped with integral magnesia-insulated cables and cable "cold" end terminations. In their "A" versions (P7A, DC12A and DC14A), the units are rated at 650 psia external pressure and have outer electrical screens with triaxial cables which, in the proper configuration of electronic equipment, ensures good rejection of external electrical interference. The three detectors will, between them, operate from about 10^2 to about 10^{11} n/cm^2/sec, a range which covers most foreseeable control instrumentation requirements. Devices for use at higher and lower fluxes have received attention, but not considered. The devices are in production for the Dungeness 'B' and P.F.R. reactors. Data were given on the performances which have been achieved. (auth)(UK)

23882 THE PROBLEMS ASSOCIATED WITH PULSE COUNTING USING IN CORE DETECTORS. Wilson, I. (Atomic Energy Establishment, Winfrith, Eng.); Oram, A. pp 44-51 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

Pulse counting channels using in-core fission detectors are necessary to achieve effective control of some power reactors during those phases of operation, such as start-up, for which neutron flux measurements based on detector mean current or statistical fluctuations are not feasible. Their successful use in practical installations has entailed complementary work on the associated electronic measuring instruments. This work and those aspects of using in-core fission detectors which have made it necessary are discussed. (auth)(UK)

23883 DATA AQUISITION SYSTEM USING PDP8/S COMPUTER FOR THE DOUNREAY FAST BREEDER REACTOR AND EXPERIMENTAL RIGS. Oliphant, A. J. (United Kingdom Atomic Energy Authority, Dounreay, Scotland); Biddle, G.; Lord, D. E. pp 108-12 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

At present data from the reactor is presented by strip-chart recorders and much time is required to analyze these records for reporting purposes. With the advent of instrumented rigs it was decided that a computer-controlled data aquisition system could process rig and reactor data and dump them on magnetic tape. This tape would then become a data tape for a much larger off-line computer to produce more convenient record formats. The software for the system would be written to present to the Reactor Operator details of certain reactor operating parameters (e.g., coolant flowrates, inlet and outlet coolant temperatures and control rod positions). The computer would carry out computations on these parameters and present the results on teletype. (auth)(UK)

23884 CONTROLLING NUCLEAR REACTORS. Raven, Anthony David (to English Electric Co. Ltd.). British Patent 1,148,093. Apr. 10, 1969. Filed Aug. 13, 1965.

In the reactor system described a graphite reflector which surrounds the core is made up of a number of members arranged for relative rotational movement to vary the size of a void or voids defining a free path for neutrons through the reflector. This allows control of core reactivity by controlling neutron escape. Various designs of such a reflector are described. (UK)

Shielding

23885 BUILD-UP OF SLOWING-DOWN NEUTRONS IN REACTOR SHIELD. Veselkin, A. P.; Egorov, Yu. A.; Netecha, M. E.; Pankrat'ev, Yu. V.; Piskunov, V. I. At. Energ. (USSR), 26: 269-78(Mar. 1969). (In Russian).

A technique of shield design with a contribution of slowing-down neutrons into a total dose rate is reported. On the basis of the removal cross-section method widely used in fast neutron dose calculations and the neutron dose build-up factor, B_n^{dose}, one can estimate the total neutron dose rate and obtain variant shield requirements. One-layer homogeneous and multilayer shields are discussed. Neutron dose build-up factors for most shielding materials are found. The values obtained by calculations and experimentally are in good agreement, the maximum deviation is not greater than 30%. B_n^{dose} experimental values were obtained during experiments in a water cooled and moderated reactor. B_n^{dose} for some materials as a function of their properties, thickness and arrangement relative to the neutron source are presented. 19 references. (auth)

23886 THERMAL AND RADIATION SHIELDING OF REACTOR VESSEL. Broder, D. L.; Popkov, K. K.; Suvorov, A. P. At. Energ. (USSR), 26: 260-9(Mar. 1969). (In Russian).

A survey of reducing the radiation heat release and damage of the reactor vessel material is given. Separate components of heat release and the results of the investigation of the thermal shielding composition influence on the vessel radiation heating are considered. Some ways of reducing the heat release are presented. The radiation damage effects of the steel reactor vessel are analyzed. Various models of simple and complex defect formations in irradiated materials are described. A study has been made of the energy dependence of the radiation neutron efficiency and its influence on the integral radiation. The results of the optimization vessel radiation shielding are given. The reactor vessel useful life is estimated. 33 references. (auth)

23887 PRINCIPLES FOR THE SHIELDING OF FAST BREEDER REACTORS. Hornyik, K. (Kernforschungszentrum Karlsruhe, Ger.). pp 157-69 of Probleme des Bautechnischen Strahlenschutzes. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).

From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

The relationship of shielding problems in fast breeders to other construction problems is examined. Breeding rate, net efficiency, critical mass, reactivity, worth of Pu, and cost factors for the radial breeding blanket are presented for a 1000 MW(e) steam cooled breeder, and neutron flux at the outer border of the breeding blanket and radial neutron flux distribution in various intermediate layers of the core of a 300 MW(e) sodium cooled breeder are given. The neutron flux in the pressure vessel is plotted for both reactor types, and the neutron energies for dislocation damage in iron are presented. (H.D.R.)

23888 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Cooke, Brian Frederick (to Nuclear Power Group Ltd.). British Patent 1,147,880. Apr. 10, 1969. Filed Mar. 3, 1967.

Reference is made to gas cooled nuclear reactors of the type in which fuel is inserted into and removed from the core through standpipes passing through the pressure vessel wall. The standpipes are provided with sealing plugs held in position against the gas pressure by locking devices. The shield floor adjacent to the ends of the standpipes consists of a number of members composed of shielding material anchored to the pressure vessel wall. The members have openings aligned with the standpipes. The openings have removable retaining devices to transmit any exerted force to the member. Each retaining device is adapted to prevent the passage of a standpipe plug through its associated opening in the shield floor member in the event of failure of the standpipe or its locking device. (UK)

23889 IMPROVEMENTS IN AND RELATING TO A NUCLEAR REACTOR VESSEL. Picaut, Jack; Puyo, Andre (to Commissariat a l'Energie Atomique). British Patent 1,148,160. Apr. 10, 1969. Priority date Apr. 19, 1967, France.

CONCRETES—pressure vessels of prestressed, with multiple horizontal metal cable hoops

PRESSURE VESSELS—gas-cooled reactor vertical cylindrical prestressed concrete, with multiple horizontal metal cable hoops

REACTORS, GAS-COOLED— pressure vessel for, description of multiple horizontal metal cable hoops in vertical cylindrical prestressed concrete (D.C.C.)

Cooling Systems

23890 (BNWL-SA-2336(Draft)) RELEASE AND MIGRATION OF IRRADIATED STAINLESS STEEL IN FLOWING SODIUM. Brehm, W. F.; Kovacevich, E. A.; Shannon, D. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1968]. Contract AT(45-1)-1830. 20p. (CONF-690502-10). Dep. CFSTI.

From 65th National Meeting of the American Institute of Chemical Engineers, Cleveland, Ohio.

Transport and deposition of radioisotopes released to flowing Na from corrosion of irradiated stainless steel has been studied. Quantitative measurements of deposition can be made with sensitive counting techniques. The results of the study indicate that ^{51}Cr and ^{60}Co are transported slowly, and do not rapidly migrate to lower temperature regions of loop systems. However, ^{54}Mn is released in larger quantities to deposit throughout the test loops. Preferential deposition sites are immediately downstream from the source, at minimum temperature locations, and in oxygen cold traps. These results indicate ^{54}Mn is transported by more than one mechanism. Deposited ^{54}Mn migrated rapidly to the cold trap, deposited ^{51}Cr and ^{60}Co migrated slowly. 10 references. (auth)

23891 (CEA-R-3716) FLICA: A CODE FOR THE THERMODYNAMIC STUDY OF A REACTOR OR A TEST LOOP. Fajeau, Maurice (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1969. 62p. (In French). Dep.

The code handles the thermal problems of water loops or reactor cores under the following conditions: high or low pressure, steady state or transient behavior, one or two phases; three-dimensional thermodynamic study of the flow in cylindrical geometry; and unidimensional study of heat transfer in heating elements. Neutronic studies can be coupled and a schematic representation of the safety rod behavior is given. The number of cells described in a flow cross-section is less than 20. (auth)

23892 (EUR-4200) THESEE 2: A CALCULATION CODE FOR PERFORMANCES AND THERMOHYDRAULIC PERTURBATIONS OF AN ORGEL REACTOR CHANNEL. Chambaud, B.; Civardi, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov. 1968. 94p. (In French). Dep.

THESEE 2 is a calculation code for performances and thermohydraulic perturbations of an ORGEL reactor channel. The code THESEE 2, programmed in FORTRAN IV language for the IBM 360 computer allows the determination of: the organic coolant temperatures fine distribution of a cluster fuel element; the cladding temperatures fine distribution around the most charged channel taking into account the local velocity distribution; and the average thermohydraulic performances of the channel of an ORGEL type reactor. 9 references. (auth)

23893 (EUR-4201) THESEE 3: A CALCULATION CODE FOR NOMINAL PERFORMANCES AND STATISTICAL HOT CHANNEL FACTORS OF AN ORGEL REACTOR CHANNEL. Chambaud, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov. 1968. 86p. (In French). Dep.

THESEE 3 is a calculation code for nominal performances and statistical hot channel factors of an ORGEL reactor channel. The THESEE 3 code programmed in FORTRAN IV language for the IBM 360 computer allows the determination of: the organic coolant and sheath fine distribution temperatures of a cluster fuel element; the average thermohydraulic performances of the channel of an ORGEL type reactor; and the fabrication tolerances statistical influence on the performances and particularly on the nominal sheath temperature. 8 references. (auth)

23894 (EUR-4206) SYNTHESIS OF ORGANIC COOLANTS FOULING STUDIES. Terrien, J. F. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec. 1968. 82p. (In French). Dep.

The most pertinent data on fouling with organic liquids is reviewed. Different fouling mechanisms are presented and compared to the experimental data. It is found that, besides the role of the radiations, the coolant quality and its purification are the most important parameters for controlling the film formation rate. Different purification units are reviewed and analyzed. 38 references. (auth)

23895 (EURAEC-2062) RESEARCH ON STEAM SEPARATION CYCLONES FOR BOILING WATER REACTORS. 10th Quarterly Report, April 1–June 30, 1968. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany)). July 17, 1968. Contract 083-66-1-TEED. 65p. (EUR-3998; AEG-E-31/E-1077). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The work on the development of a downflow cyclone type steam separator for use in large BWR's with direct cycle is described. The measurements for optimizing the dimensions of the single cyclone are presented. The first two cyclones have different water outlet pieces. The maximum air flow during the tests was 600 m3/hr, which is the maximum capacity of the air compressor. The air carryunder was so small that the steam carryunder X_R calculated from this data was below 0.2 wt % mixture quality in a BWR downcomer. The third cyclone tested has a reduced diameter steam outlet pipe. In addition to the instrumentation of earlier cyclones, special pressure taps were provided in the separation pipe. They show an internal circulation inside the cyclone which probably cannot be neglected. This secondary eddy circulates vertically to the plane of the primary rotation. Special water tests were made to find out the effect of the angle flow direction and pressure taps. (auth)

23896 (EURFNR-615) FAST REACTOR CORE HEAT REMOVAL. Smidt, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Nov. 1968. 38p. (KFK-883; EUR-4162). Dep.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The problem of optimizing fast reactor design parameters while maintaining sufficient core cooling potentials is analyzed. The reactor model discussed has a core of multiple parallel metal clad rods filled with PuO_2-UO_2. Coolant possibilities which are analyzed include: gas, steam; and liquid Na. 69 references. (D.C.C.)

23897 (TID-25012) LUMPED-PARAMETER ANALYSIS OF CYLINDRICAL PRESTRESSED CONCRETE REACTOR VESSELS. Civil Engineering Studies Structural Research Series No. 340. Gomez, A. Echeverria; Schnobrich, W. C. (Illinois Univ., Urbana). Dec. 1968. Contract W-7405-eng-26; Subcontract No. 2906. 101p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

The development of a mathematical procedure suitable for the analysis of prestressed concrete pressure vessels in both elastic and inelastic ranges is presented. A lumped parameter approach offers a number of advantages in the treatment of localized inelastic behavior. Axial and radial displacements, as well as stresses and strains, are calculated at various points in the body of the vessel at various stages of loading. Material properties, at the nodes representing the continuum, are evaluated according to whether elastic behavior or cracking prevails at that particular location. The results illustrate the behavior of a sample vessel from regular operational level of internal pressure to the advanced state of cracking which precedes complete failure. 25 references. (D.C.C.)

23898 PROBLEMS IN THE CONSTRUCTION OF REINFORCED CONCRETE VESSELS FOR NUCLEAR REACTORS. Zerna, W. (Ruhr-Univ., Bochum, Ger.). pp 171-7 of Probleme des Bautechnischen Strahlenschutzes. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).

From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

Prestressing methods used in the construction of concrete pressure vessels are briefly described. (H.D.R.)

23899 STATIC MODEL INVESTIGATION OF THE STATE OF STRESS IN A REACTOR PRESSURE VESSEL. Hansson, V. (Technische Univ., Hanover). pp 179-207 of Probleme des Bautechnischen Strahlenschutzes. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).

From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

The dimensions, cylinder and cover plate molds, sensor and instrumentation arrangement, and hydraulic system used in fabricating and stress testing models of reactor pressure vessels are described. Expansion, displacement, and stress data obtained in the static tests are presented. (H.D.R.)

23900 REINFORCED CONCRETE PRESSURE VESSEL FOR WATER COOLED REACTORS. Gruhl, H. (Siemens-Schuckertwerke AG, Erlangen, Ger.). pp 209-23 of Probleme des Bautechnischen Strahlenschutzes. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).

From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

Development efforts on construction principles for prestressed concrete pressure vessels for water cooled reactors are described. Design aspects of the vessel, vessel insulation requirements, and the research program on vessel models are presented. (H.D.R.)

23901 MATERIALS PROBLEMS FOR REACTOR PRESSURE VESSELS FOR WATER COOLED REACTORS. Tietze, A. (Technische Ueberwachungsvereine e.V., Cologne). pp 225-41 Probleme des Bautechnischen Strahlenschutzes. III. Schultz, H. (ed.). Munich, Verlag Karl Thiemig KG, 1968. (In German).

From Conference on Radiation Protection, Erlangen, Ger. See CONF-671137.

Design and materials requirements of steel pressure vessels are examined, and the behavior of reactor pressure vessels under deformation conditions is discussed. Modes of embrittlement from stress and temperature effects and the dependence of impact strength on operating parameters are described. (H.D.R.)

23902 MEASUREMENT OF TEMPERATURE NOISE IN AN OUT-OF-PILE HEAT TRANSFER LOOP. Nishihara, Hideaki; Ohtsubo, Akira (Kyoto Univ.). J. Nucl. Energy, 23: 99-111(Mar. 1969).

Temperature noise or fluctuation in an out-of-pile heat transfer loop was measured and analyzed. Air was passed through a round heated steel pipe of 30.0 mm ID with Reynolds numbers 2.5×10^4 and 5.0×10^4. The fluctuating temperature of the air was measured by a fast response thermocouple in the thermal entrance region as well as in the thermally developed region at a number of radial positions. Power spectral density, autocorrelation function, amplitude distribution, and the profile of the temperature fluctuation across the flow channel were measured. Power spectral density, plotted in terms of the local wave number, was almost identical for different runs. Assumption of alternating random telegraph signal for the fluctuating temperature gave a measure of hot and cold lumps. (auth) (UK)

23903 PUMPING SYSTEM FOR A NUCLEAR REACTOR. Bray, Arthur Philip (to General Electric Co.). British Patent 1,148,179. Apr. 10, 1969. Priority date June 3, 1965, United States.

PUMPS—jet, description of boiling reactor pressure vessel contained multiple
REACTORS, BOILING—pumps for, description of pressure vessel contained multiple jet (D.C.C.)

23904 BOILING HEAVY WATER INDIRECT-CYCLE REACTOR. Fajeau, Maurice (to Commissariat a l'Energie Atomique). British Patent 1,149,837. Apr. 23, 1969. Priority date Apr. 25, 1967, France.

HEAT TRANSFER SYSTEMS—description of heavy water-cooled and -moderated boiling reactor indirect cycle
REACTORS, BOILING—cooling system for heavy water-cooled and -moderated, description of indirect cycle
REACTORS, HEAVY WATER-MODERATED—cooling system for heavy water-cooled boiling, description of indirect cycle (D.C.C.)

23905 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Martin, Georges (to Societe Des Forges Et Ateliers Du Creusot). British Patent 1,149,700. Apr. 23, 1969. Priority date Sept. 20, 1967, France.

HEAT TRANSFER SYSTEM—description of graphite-moderated gas-cooled reactor core supporting multiple heat exchangers closed loop
REACTORS, GAS-COOLED—cooling system for graphite-moderated, description of core supporting multiple heat exchanger closed loop,
REACTORS, GRAPHITE-MODERATED—cooling system for gas-cooled, description of core supporting multiple heat exchangers closed loop (D.C.C.)

23906 INDIRECT-CYCLE INTEGRAL STEAM COOLED NUCLEAR REACTOR. Nakanishi, Tetsuichiro (to Hitachi Zosen Kabushiki Kaisha). U. S. Patent 3,434,926. Mar. 25, 1969. Filed Aug. 11, 1965.

A nuclear reactor comprises a reactor vessel containing water and is composed of a vertical elongated pressure vessel with inlet nozzles. A reactor core is provided inside the vessel. This shell with enclosed tubes and pipes constitutes a shell and tube heat exchanging means which is integrated with the reactor vessel. Steam generating is effected by directly contacting with water contained in the reactor vessel and thus the circulating steam always remains as steam until it reaches the water in the reactor vessel. Water heating and evaporating means is provided inside the reactor vessel. Means is provided inside the reactor vessel for superheating steam by passing it through passages in the reactor core. Secondary steam is generated from water derived from the shell side of the heat exchanging means. The steam is re-circulated. Thermal shields are provided inside the reactor vessel and a stream of water flows in contact with the thermal shields to moderate the nuclear fuel and may be circulated by a pump. The heat exchanging means may comprise two coils mounted inside the shell which are heated by superheated steam. (Offic. Gaz.)

23907 HEAT EXCHANGER OF A NUCLEAR REACTOR. Weber, Max (to Sulzer Brothers, Ltd.). U. S. Patent 3,425,906. Feb. 4, 1969. Priority date Apr. 7, 1965, Switzerland.

The nuclear reactor described includes a heat exchanger which is constructed with a grate formed with multiple apertures. Multiple heat exchange elements are mounted over the apertures. The grate is disposed within a duct of the heat exchanger to divide the duct into an upper and lower chamber. The heat exchange elements are disposed in the upper chamber to conduct a primary coolant into the lower chamber. (Offic. Gaz.)

23908 NUCLEAR ENERGY REACTOR PLANT HAVING ONE OR MORE HEAT EXCHANGERS. Bonsel, Wouter G.; Weevers, Henry H. (to Reactor Centrum Nederland). U. S. Patent 3,425,907. Feb. 4, 1969. Priority date Sept. 20, 1965, Netherlands.

A nuclear reactor plant with a number of heat-exchangers connected with co-axial conduits to the reactor vessel is described. The same vessel and the same core lay-out may be adopted for multiple power levels. For the required power level of the reactor ordered, only minor changes in prefabricated parts will be necessary. (Offic. Gaz.)

23909 NUCLEAR REACTOR. Petersen, Eirik Nicoll (to Institutt for Atomenergi). U. S. Patent 3,429,775. Feb. 25, 1969. Priority date June 17, 1965, Norway.

This invention relates to boiling nuclear reactors and means for maintaining a uniform flow of circulating cooling fluid through the core. This is accomplished by a restricted flow section in the downcomer in the reactor. (Offic. Gaz.)

Fuels

Refer also to abstract 22505.

23910 (IN-1277) BURNUP DETERMINATION OF NUCLEAR FUELS. Project Report for the Quarter, April 1–June 30, 1968 and Final Report. Lisman, F. L.; Maeck, W. J.; Rein, J. E.; Foster, R. E. Jr.; Abernathey, R. M.; Delmore, J. E. Jr.; Emel, W. A.; Kussy, M. E.; McAtee, R. E.; Workman, G. D. (Idaho Nuclear Corp., Idaho Falls). Mar. 1969. Contract AT(10-1)-1230. 115p. Dep. CFSTI.

Methods are being developed for accurate determination of the burnup of nuclear fuels, new measurements are reported for the thermal fission yields of ^{125}Sb and the stable isotopes of molybdenum for ^{233}U; ^{141}Ce, ^{125}Sb, and the stable isotopes of molybdenum for ^{235}U; ^{125}Sb, the stable isotopes of molybdenum, the stable and long-lived isotopes of ruthenium, the stable isotopes of samarium, and mass chains 95, 97, and 99 for ^{239}Pu; ^{125}Sb, the stable and long-lived isotopes of ruthenium, and mass chains 95, 97, and 99 for ^{241}Pu. Also reported are new measurements of the fast (EBR I) fission yields of ^{125}Sb and the stable isotopes of molybdenum for ^{235}U; and of ^{125}Sb and the long-lived and stable isotopes of Ba, Cd, Ce, Cs, Kr, Mo, Nd, Rb, Sm, Sr, Xe, and Zr for ^{239}Pu. A comprehensive listing is presented for all the fission yield data obtained in the program. Included are thermal fission yields for ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu and fast fission yields for ^{235}U and ^{239}Pu. Finally, various fission products are recommended as nuclear fuel burnup monitors for various fuel types. Monitors are proposed for determination of total fissions in monoisotopic and polyisotopic fissioning fuels and for the relative fissions from individual fissionable isotopes in several duoisotopic fuels. (auth)

23911 (JNPC/SWP/N-40 and (Amend.1)) FISSION PRODUCT AND HEAVY ISOTOPE CONTENT OF CIVIL A.G.R. FUEL. Lewin, D. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). [nd]. 35p. Dep.

A listing of fission products and heavy isotope content in Windscale Advanced Gas-Cooled Reactor fuel elements is presented. 16 references. (auth)

23912 (KFK-722) THE AMOUNTS OF FISSION PRODUCT NUCLIDES PRODUCED IN ^{239}Pu-FUELLED FAST REACTORS AND THE RELATED HEAT GENERATION AFTER SHUT-DOWN. Gupta, D.; Heller, F.; Schroeder, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Nov. 1968. 19p. Dep.

To obtain the decay heat generated by the fission products of ^{239}Pu, first the concentration of individual fission products was calculated as a function of in-pile time, cooling time, and specific power of the reactor. The equations used and the results of these calculations are presented and discussed. On the basis of these results, the activities and the decay power of individual fission product nuclides were calculated and, finally, these quantities were combined to result in data for gross fission products. These latter calculations and their results are presented and discussed. 31 references. (auth)

23913 (ORNL-TM-2318) DETERMINATION OF THE VOID FRACTION IN THE MSRE USING SMALL INDUCED PRESSURE PERTURBATIONS. Robinson, J. C.; Fry, D. N. (Oak Ridge National Lab., Tenn.). Feb. 6, 1969. 56p. Dep. CFSTI.

With the Molten-Salt Reactor Experiment (MSRE) operating at 5 MW, sawtooth pressure perturbations were introduced into the fuel-pump bowl to determine the amount of helium gas entrained in the circulating fuel. The pressure and neutron flux signals were simultaneously amplified and recorded on magnetic tape. Then the signals were analyzed using auto-power spectral density, cross-power spectral density, cross-correlation, and direct Fourier transform techniques to obtain the neutron-flux-to-pressure frequency-response function. An analytical model, developed previously to aid in the interpretation of the fluctuations of the neutron flux in an unperturbed system, was used to infer from the experimental data the amount of helium void (interpreted as a void fraction) entrained in the fuel salt. A description of the analytical model and its experimental verification are included. The void fraction was determined to be between 0.023 and 0.045%. The uncertainty of this inference is attributed to assumptions made in the model. (auth)

23914 FUEL ELEMENT PROBLEMS OF STEAM-COOLED FAST BREEDERS. Boehm, H. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt. Atomtech., 14: 210-11(Apr. 1969). (In German).

Problems with fuel element cladding materials for steam cooled fast breeder reactors are discussed. Corrosion problems are described; radiation damage and high neutron flux exposure effects are detailed. Results of radiation effects and mechanical properties testing are tabulated. (M.L.S.)

23915 FUEL ELEMENT PROBLEMS OF STEAM-COOLED FAST BREEDERS. Ritz, L. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt. Atomtech., 14: 207-10(Apr. 1969). (In German).

The fuel elements developed for the steam cooled fast breeder reactor are described. These fuel elements are cylindrical with helical ribs which form an integral part of the clad. The function of the helical ribs is described with respect to coolant mixing and heat transfer; lateral mixing is shown as a function of surface temperature. Use of the inner-rib configuration for increase of fuel rod power per unit length is discussed; power per unit length is given as a function of temperature. Load capacity of fuel materials is discussed briefly. (M.L.S.)

23916 FUEL ELEMENT PROBLEMS OF STEAM-COOLED FAST BREEDERS. Fischer, M. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt. Atomtech., 14: 203-6(Apr. 1969). (In German).

The fuel elements used in the development studies for the steam cooled fast breeder reactor are described. Effects of the high temperatures and pressures which occur in this type of reactor are evaluated. Steam system pressures and temperatures which cause dimensional changes are given. Heat transfer from the fuel bundles to the coolant is discussed. Some criteria used in the selection of fuel clad materials are given; materials which were tested are listed. Technical and economic data for the various types of fuel rods for the steam cooled fast breeder are tabulated. Effects of inner-ribbed fuel elements on the breeding rate, fission product inventory, and economy are evaluated; data are shown graphically. (M.L.S.)

23917 ATOMIC POWER PLANTS. Feinberg, S. M. Izv. Akad. Nauk SSSR, Energ. Transp., No. 1, 3-31(Jan.-Feb. 1969). (In Russian).

A review of the main achievements in technology and economics that have been a part of thermal reactor power stations is presented. The effects of predicted U fuel supplies on the development of reactor power stations are analyzed. The development of Th-fueled breeder thermal reactors is discussed. The effects of fast and thermal breeder reactors on economic U fuel supplies are described. The development of an optimum economic reactor type is discussed. (tr-auth)

23918 THERMAL CONTRIBUTION TO THE FUEL-TEMPERATURE COEFFICIENT IN WATER-MODERATED POWER-LATTICE CELLS. Stamm'ler, R. J. J. (Allmaenna Svenska Elektriska Aktiebolaget, Vaesteras, Sweden). Nukleonik, 12: 53-7(Jan. 1969).

The contribution to the fuel-temperature coefficient, which comes from the thermalizing properties of the oxygen in oxide-fueled lattices, changes considerably with burnup, i.e., with the plutonium concentration. This thermal contribution has been studied for water-moderated lattices as a function of the void content, the fuel-rod size, the ^{239}Pu concentration, and burnup. This contribution will never override the epithermal (Doppler) part of the fuel-temperature coefficient in a light water-moderated lattice. In a heavy, water-moderated reactor, however, this effect will seriously deteriorate the total fuel-temperature coefficient, which in some cases may approach zero, or even turn positive with increasing burnup. 7 references. (auth)

23919 LOCAL HEAT TRANSFER COEFFICIENTS IN SPIRAL-FINNED REACTOR FUEL RODS WITH PARALLEL COUNTER CURRENT FLOW. Eifler, W.; Nijsing, R. (EURATOM, Ispra, Italy). Nucl. Eng. Design, 9: 211-33(Feb. 1969). (In German).

A description is given of heat transfer experiments in an assembly of four helically finned tubes. The aim was to provide thermal design information for 7-rod fuel elements developed in the framework of the ORGEL Project. Heat transfer was studied in an annular test section for the case of both a concentric and a completely excentric test rod mounting. The results obtained were employed to furnish a detailed analysis of subsequent measurements in a 4-rod test section. To evaluate local heat transfer coefficients, temperatures were measured inside the thermal fins of the test tubes. A simple calculation method is indicated to interpret these temperature measurements. 10 References. (auth)

23920 REFUELLING APPARATUS FOR A NUCLEAR REACTOR. Benoist, Etienne; Michot, Gilbert (to Commissariat a l'Energie Atomique). British Patent 1,148,154. Apr. 10, 1969. Priority date Jan. 26, 1967, France.

REACTOR LOADING MACHINES—fast liquid metal-cooled reactor shielded valve sealed dual oblique ramp, description of
REACTORS, FAST—loading machine for liquid metal-cooled, description of shielded valve sealed dual oblique ramp
REACTORS, LIQUID METAL-COOLED—loading machine for fast, description of shielded valve sealed dual oblique ramp (D.C.C.)

23921 FUTURE OUTLOOK OF PLUTONIUM AS NUCLEAR FUEL. Strasser, Alfred (United Nuclear Corp., Elmsford, N. Y.). 10p. of International Nuclear Power Day. Sandviken, Sweden, Sandvik Steel Works, 1968.

From Conference on International Nuclear Power Day, Sandviken, Sweden. See CONF-681124.

An analysis of Pu production by thermal and fast breeder reactors is presented. The performances of PuO_2-UO_2 and PuC–UC fuels are compared. Plutonium recovery predictions are presented to 1990. (D.C.C.)

23922 FUEL DISCHARGING MACHINE FOR A NUCLEAR REACTOR. Bregeon, Louis; Dupuy, Gerard (to Commissariat a l'Energie Atomique). British Patent 1,150,000. Apr. 23, 1969. Priority date Apr. 6, 1967, France.

REACTOR LOADING MACHINES—description of pressurized heavy water-cooled reactor valve sealed overhead flexible grab
REACTORS, PRESSURIZED-WATER—loading machine for heavy water-cooled, description of valve sealed overhead flexible grab (D.C.C.)

23923 NUCLEAR REACTOR AND REFUELING CELL ARRANGEMENT. (to Westinghouse Electric Corp.). British Patent 1,149,480. Apr. 23, 1969. Priority date Apr. 7, 1967, United States.

REACTOR LOADING MACHINES—description of liquid metal-cooled reactor valve sealed overhead high temperature cover gas
REACTORS, LIQUID METAL-COOLED—loading machine for, description of valve sealed overhead high temperature cover gas (D.C.C.)

23924 NUCLEAR REACTORS. Greenhalgh, Frank Geoffrey; Cairns, Walter John (to United Kingdom Atomic Energy Authority). U. S. Patent 3,425,905. Feb. 4, 1969. Priority date July 22, 1965, Great Britain.

A nuclear reactor is described which has a fuel assembly suspended within a vertical tube. The lower end of the assembly is freely encircled by a collar in contact with the tube. Limited clearance between the lower end of the assembly and the collar enables the lower end to vibrate, but prevents the assembly contacting and damaging the tube. (Offic. Gaz.)

23925 CYCLE OF Th–U-Pu SYSTEM ON FAST BREEDER. I. Hayasaka, Hideo; Takeda, Seiiti (Tohoku Univ., Sendai). Nippon Genshiryoku Gakkaishi, 11: 87-95(Feb. 1969). (In Japanese).

Recycling patterns and the long-time behavior of Pu–Th–U fueled fast breeder reactors have been investigated. The basic cycle adopted was to charge fertile materials (^{232}Th,^{238}U) into both core and blanket, to sell a portion γ_B of the fissile materials (^{233}U, ^{239}Pu) formed in the blanket, and to recharge the remaining $1-\gamma_B$ into core. Of the fuel produced in the core a part, γ_C, is sold in the market. In this fuel cycle, γ_B and γ_C are either time dependent variables or else constant, so that four alternative recycling patterns were considered with different combinations of these factors. To facilitate the procedures of refabrication and estimation of Doppler effect, the system is controlled in such manner as to let the charging ratio into core and the composition ratio of ^{232}Th and ^{238}U in blanket both be constant. The burnup equations for these recycling patterns have been derived as linear and non-linear differential equations. Breeding rates can be determined by solving the eigenvalue problems of these burnup equations. 9 references. (auth)

Auxiliary and Emergency Systems

Refer also to abstract 22581.

23926 (CONF-680821-, pp 13-26) AIR CLEANING SYSTEMS: REVIEW AND PROJECTION. Viles, F. J. Jr. (Harvard School of Public Health, Boston, Mass.).

Filter-charcoal air cleaning systems and their application, testing, and suggested further development are described for cleanup of containment atmospheres following fission product release from reactor water coolant failures. Decontamination of containment air by condensation processes, sprays, gas phase reactions, foams and diffusion boards are discussed briefly and their use noted as supportive operations to effect more rapid cleanup. Comparisons of air cleaning problems and design are made between water and sodium cooled reactors accidents. 12 references. (auth)

23927 (CONF-680821-, pp 27-54) FACILITIES AND PROCEDURES FOR TESTING LARGE SCALE AIR CLEANING SYSTEMS CONTAINMENT SYSTEMS EXPERIMENT. Linderoth, C. E.; McCormack, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The primary facilities of the Containment Systems Experiment are described in brief and pertinent physical data provided. The equipment designed for the internal air cleaning system is described in some detail. A series of six experiments is discussed which has the objective of determining the effect of a recirculating filter system on behavior of fission products in containment under post accident conditions. (auth)

23928 ARRANGEMENT FOR PREVENTING SHUTDOWN OF A NUCLEAR REACTOR PLANT WHEN THE LOAD ON A TURBINE DRIVEN THEREBY DECREASES SUDDENLY. Kaipainen, Arto; Rullgard, Ake; Skygge, Carl Gosta; Sundqvist, Cnut (to Allmaenna Svenska Elektriska Aktiebolaget). U. S. Patent 3,437,557. Apr. 8, 1969. Priority date Apr. 7, 1966, Sweden.

To prevent power reactor shutdown if the electric network is suddenly disconnected, the steam in the reactor enclosure is led through rapidly opening valves which are opened in response to a sudden decrease in turbine load. The steam passes into a tank of water, after which these valves are closed. The steam is then led through a dumping valve to a condenser connected to the turbine. (Offic. Gaz.)

Operation and Economics

Refer also to abstract 22695.

23929 (LA-4140) ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT (UHTREX). Quarterly Status Report for Period Ending January 31, 1969. (Los Alamos Scientific Lab., N. Mex.). Mar. 31, 1969. Contract W-7405-eng-36. 20p. Dep. CFSTI.

Highlights of project activities are summarized for the period of November 1968 to January 1969. Topics discussed include:

reactor operations; reactor physics; and engineering research and development. 7 references. (D.C.C.)

23930 (ORNL-TM-2555) A DISCUSSION AND EVALUATION OF REMOTE MAINTENANCE IN A REACTOR EXPERIMENT VERSUS CONVENTIONAL MAINTENANCE FOR A SIMILAR TASK. Spencer, W. F. (Oak Ridge National Lab., Tenn.). Apr. 10, 1969. 7p. Dep. CFSTI.

A description of the remote-handling procedures required to remove the leaking quick disconnect fittings of the MSRE air lines is presented. (D.C.C.)

23931 MOLTEN-SALT REACTOR PROGRESS. Haubenreich, P. N. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Int., 14: 325-9(Apr. 1969).

The American MSRE is described. Operating experience after 20,000 h is discussed in terms of fuel chemistry, materials compatibility, chemical processing, reactivity, stability, and equipment reliability. (UK)

23932 FUTURE POWER GENERATION COSTS WITH HIGH TEMPERATURE REACTORS. Schulten, R. (Kernforschungsanlage, Juelich, Ger.). Chem.-Ing.-Tech., 41: 144-5(Feb. 1969). (In German).

Requirements for net installed power for the German Federal Republic are projected through 1990. Production costs are considered for nuclear power plants; effects of fuel and fuel cycle costs are discussed. Uses of hard coal reserves are outlined. (M.L.S.)

23933 FUTURE POWER GENERATION COSTS WITH FAST BREEDER REACTORS. Seetzen, J. (Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ing.-Tech., 41: 141-4(Feb. 1969). (In German).

Nuclear power stations currently under construction or in the planning stage are based on light-water reactors (LWR). The second generation reactors are envisaged as fast breeders which will not only produce electricity at least as cheaply as those of the first but will also ensure a cheap supply of electricity in the long term and guarantee supplies for the future. In Germany, this development is being pursued energetically in cooperation with the Benelux countries. (auth)

Safety and Siting

23934 (AI-AEC-12744, pp 53-60) BOILING-STUDIES FOR SODIUM-REACTOR SAFETY. Logan, D.; Landoni, J.; Baroczy, C. (Atomics International, Canoga Park, Calif.).

The results from 100 liquid sodium superheating transients at 5 and 15 psia with a highly polished beaten surface are listed. The liquid superheating exhibited random scatter. (D.C.C.)

23935 (BNWL-1009) NUCLEAR SAFETY BRANCH OF USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY QUARTERLY REPORT, NOVEMBER 1968-JANUARY 1969. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1969. Contract AT(45-1)-1830. 161p. Dep. CFSTI.

- ACOUSTIC EMISSION TESTING—pipe failure detection by, development and testing of components for reactor pressure
- CALCINATION—spray equipment and procedures development for radioactive waste solutions
- CONTAINMENT SYSTEMS EXPERIMENT—spray systems effectiveness in reduction of gaseous iodine concentration in
  - —blowdown studies in, description of simulator vessel and primary restraint system for
  - —coolant blowdown in, comparison of calculated and measured pressure and temperature transients for
- GLASS—production of phosphate, for fixation of radioactive wastes
- IODINE—removal of gaseous, effectiveness of reactor containment spray systems for
- PIPES—failure detection of reactor pressure, development of acoustic emission signal test for
- RADIOACTIVE WASTE—fixation by conversion to phosphate glass, evaluation of test runs for
  - —solidification of solutions of, spray calcination equipment and procedures development for
- REACTOR CONTAINMENT SYSTEMS—iodine removal from, effectiveness of spray systems for gaseous
- REACTOR SAFETY—coolant blowdown in Containment Systems Experiment simulator vessel, comparison of calculated and measured pressure and temperature transients for
- STEEL—microstructure of quenched and tempered A302-B pressure vessel plate, correlation of fracture toughness with

(D.C.C.)

23936 (CONF-680821) PROCEEDINGS OF THE TENTH AEC AIR CLEANING CONFERENCE HELD IN NEW YORK, NEW YORK, AUGUST 28, 1968. First, Melvin W.; Morgan, James M. Jr. (eds.) (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab. Division of Reactor Development and Technology (AEC), Washington, D. C.). Dec. 1968. 388p. Dep. CFSTI.

Topics discussed conerning air cleaning are grouped in three main categories: air cleaning systems; air cleaning system components; and adsorbents for iodine. Separate abstracts are included for each of the 22 papers presented. (D.C.C.)

For abstracts of individual papers see: 21679, 21854, 21923, 21924, 21935, 23926, 23927, 23937, 23938, and 24017-24029.

23937 (CONF-680821-, pp 204-26) EFFECT OF GAMMA RADIATION ON ADSORPTION OF IODINE AND METHYL IODIDE ON ACTIVATED CARBON. Jones, L. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

The effect of γ radiation on the adsorption of iodine and methyl iodide on activated carbon exposed to flowing mixtures of steam and air is being measured at the Savannah River Laboratory. The steam-air-iodine mixtures are exposed to a radiation field of $\approx 2 \times 10^7$ rads/hr while flowing through a bed of test carbon. Preliminary tests, in which only relative humidity and velocity have been varied, show that the radiation field decomposed up to 90% of the methyl iodide. Test conditions simulated a postulated loss-of-coolant accident where adsorption of radioiodine on carbon beds in the confinement system would produce an intense γ radiation field. 8 references. (auth)

23938 (CONF-680821-, pp 330-4) USE OF AGGLOMERATION MODELING IN DETERMINING THE SOURCE TERM FOR REACTOR SITING EVALUATIONS. Koontz, R. L.; Hausknecht, D. F.; Morewitz, H. A. (Atomics International, Canoga Park, Calif.).

An equation has been obtained which shows that the fraction of the released mass which leaks from a reactor enclosure varies (at a constant leak rate and height of building) inversely as the square of the mass median particle radius. Additionally, if the mass median radius is proportional to the released mass concentration the leaked fraction decreases as the mass concentration increases. (auth)

23939 (IN-1172) FISSION PRODUCT BEHAVIOR UNDER SIMULATED LOSS-OF-COOLANT ACCIDENT CONDITIONS IN THE CONTAMINATION-DECONTAMINATION EXPERIMENT. Freeby, W. A.; Lakey, L. T.; Black, D. E. (Idaho Nuclear Corp., Idaho Falls). Jan. 1969. Contract AT(10-1)-1230. 81p. Dep. CFSTI.

A pilot-plant-scale facility, the Contamination-Decontamination Experiment, was built and operated to produce mixtures of high-level, short-cooled (6- to 10-hr) fission products under conditions simulating an unperturbed loss-of-coolant reactor accident. The mixtures were created by melting irradiated, zirconium-clad UO_2 fuel pins in steam. The fission products released from the fuel were transported by steam to an 86 ft^3 vessel containing a saturated air-steam atmosphere. Extensive data on fission product behavior were obtained during five runs in the facility and are reported. The measured release fractions of fission products from the grossly melted fuel were comparable to the release fractions suggested in TID-14844, except for those of tellurium, cesium, and molybdenum, which were a factor of approximately 10 higher. Of the fission products released from the fuel, except the noble gases, most of the cesium and zirconium, little of the molybdenum and ruthenium, and $^1/_{10}$ to $^1/_3$ of the other fission products were deposited in the transport line. In the containment vessel, where the natural behavior of the fission products was observed as the steam-air atmosphere was allowed to cool, the concentrations of noble gases and organic iodides remained essentially constant. The radioiodine and particulate activities in the vessel atmosphere dropped rapidly (half time of approximately 8 min) for 30 min after injection of fission products into the vessel. The depletion rate of the radioiodine activity then slowed considerably (to a halftime of approximately 7 hr). After a 24-hr cooling period, approximately 3% of the radioiodine and approximately 0.2% of the particulate activities injected into the vessel remained in the atmosphere. Tin, volatilized from the cladding, made up most of the mass of particulate matter released to the containment vessel. About one-half the activities removed from the atmosphere was found in the condensate; the other one-half deposited on the vessel surfaces. Condensation was observed to enhance removal of fission products from the atmosphere; cold surfaces in the vessel received more deposition than warm surfaces, and increasing the steam injected into the atmosphere increased the removal of fission products with the condensate. "Maypack" type samplers indicated that 1 to 2% of the radioiodine inventory in the fuel was present in the containment vessel as organic iodides. Subsequent laboratory and tracer runs show that much of this may instead be another iodine species, hypoiodous acid. (auth)

23940 (ORNL-4360) SPRAY AND POOL ABSORPTION TECHNOLOGY PROGRAM. Row, T. H. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 32p. Dep. CFSTI.

There has been a significant increase in the number of nuclear power plants under construction or scheduled in the past two years. The requirements for additional sites have dictated that reliable engineered safeguards be proven. The present plant designs include containment building spray systems for pressurized-water reactors and pressure-suppression pools for boiling-water reactors. A search for solutions exhibiting a high removal rate for molecular and organic iodine is described. The best solutions from this search are used in single-drop wind-tunnel experiments to determine the removal characteristics more accurately. The additives most applicable to industrial uses are then applied in engineering-scale tests, in addition to corrosion and thermal and radiation stability tests. (auth)

23941 (ORNL-NSIC-57) COMPILATION OF UNITED STATES NUCLEAR STANDARDS. 5th Edition, 1968. (Oak Ridge National Lab., Tenn.). Apr. 1968. Contract W-7405-eng-26. 161p. Dep. CFSTI.

A complete list of codes and standards which are applicable to the nuclear industry is presented. The standards activities of all organizations, including technical societies and government agencies, are tabulated. 52 references. (D.C.C.)

23942 (ORNL-NSIC-59) INDEXED BIBLIOGRAPHY OF CURRENT NUCLEAR SAFETY LITERATURE-18. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 285p. Dep. CFSTI.

The indexed bibliography of current nuclear safety is presented. Bibliographic items are sorted into the following categories: General Safety Criteria; Siting of Nuclear Facilities; Transportation and Handling of Radioactive Materials; Aerospace Safety; Accident Analysis; Reactor Transients, Kinetics, and Stability; Fission Product Release, Transport, and Removal; Sources of Energy Release Under Accident Conditions; Nuclear Instrumentation, Control, and Safety Systems; Electrical Power Systems; Containment of Nuclear Facilities; Plant Safety Features; Radiochemical Plant Safety; Radionuclide Release and Movement in the Environment; Environmental Surveys, Monitoring and Radiation Exposure of Man Meteorological Considerations; Operational Safety and Experience; Safety Analysis and Design Reports; and Bibliographies. (D.C.C.)

23943 (ORNL-NSIC-60) INDEX TO NUCLEAR SAFETY. A TECHNICAL PROGRESS REVIEW BY CHRONOLOGY, PERMUTED TITLE, AND AUTHOR, VOL. 1, NO. 1 THROUGH VOL. 9, NO. 6. Blakely, J. P.; Klein, Ann (Oak Ridge National Lab., Tenn.). Mar. 1969. Contract W-7405-eng-26. 94p. Dep. CFSTI.

A bibliography of Nuclear Safety articles is presented. The bibliography is separated into three sections: chronological lists of articles; permuted title index; and authors index. (D.C.C.)

23944 (RT/FI-(68)45) SPES-1: IBM 7094 PROGRAM FOR THE STUDY OF PROMPT-CRITICAL UNCONTROLLED EXCURSIONS IN FAST REACTORS. Azzoni, P.; Carpene, A.; De Cecco, L.; Poli, P.; Ricci, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 45p. (In Italian). (PRV-r-(68)17). Dep.

The SPES-1 computer program calculates the energy release in an uncontrolled prompt-critical accident of a Na-cooled fast power reactor. The computer code is based on the well-known Bethe-Tait method and is improved by taking into account the effect of the possible Na presence in the core channels. The code, written in FORTRAN IV for a 7094 IBM computer, takes into account the Na behavior on the basis of an analytical theory, developed for this purpose, which describes the behavior of a cylindrical Na sample under radial uniform pressure. 5 references. (auth)

23945 THE LOSS-OF-COOLANT ACCIDENT ANALYSIS IN PRESSURIZED WATER REACTORS. Nahavandi, Amir N. (Univ. of Vermont, Burlington). Nucl. Sci. Eng., 36: 159-88(May 1969).

A generalized digital computer approach to analyze the loss-of-coolant accident in pressurized water reactors requires a systematic specification of the plant geometric, physical, and topological characteristics and initial conditions. The solution of the problem is hampered by numerical stability and convergence problems which can be remedied by first classifying the problem variables into three categories: numerically integrated; analytically integrated; and auxiliary algebraic variables. Second, in view of the occurrence of the acoustic wave phenomenon, the maximum allowable integration time step should be kept much smaller than the subharmonics present in the solution. Another distinctive feature is the treatment of stratified elements, such as the pressurizer or the steam generator secondary. Allowance for mass exchange between the top and bottom control volumes in these elements is made by the introduction of bubble rise and condensate drop velocity concepts. Furthermore, to eliminate unrealistic pressure fluctuations in the ruptured elements at the onset of two-phase blowdown, critical flow models including inertia effects are introduced. To verify the sensitivity of the solution to various two-phase frictional loss correlations, five well-known correlations are reviewed. A comparison of the analytical results against LOFT experimental data demonstrates a good agreement and shows that a more accurate prediction would require the introduction of metastability analysis. 39 references. (auth)

Research and Test Reactors

Refer also to abstracts 22056, 22620, 23610, 23848, and 24014.

23946 (AI-AEC-12744) AEC UNCLASSIFIED PROGRAMS. Quarterly Technical Progress Report, July-September 1968. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. 189p. Dep. CFSTI.

Separate abstracts are included for each of the 22 sections presented. The subject areas which are investigated by the programs include: cross-section analysis; fast-spectrum Doppler measurements; Monte Carlo methods; Na fire fission product release; Na boiling safety studies; coolant management; materials management; Na mechanical properties; fabrication, irradiation, and mechanical properties of mixed carbide fuels; Na chemistry; HNPF retirement; high-temperature chemistry; radiation chemistry; electronic structure of metals and alloys; radiation damage in crystalline solids; radiation chemistry of chromosomes; and noise analysis instrumentation. (D.C.C.)

For abstracts of individual sections see: 21676, 21677, 21726, 21727, 22458, 22459, 22577-22579, 22645, 22646, 23022, 23809, 23810, 23874, 23934, 23947-23950, 24015, and 24016.

23947 (AI-AEC-12744, pp 5-9) CROSS-SECTION ANALYSIS. Alter, H.; Dunford, C. L. (Atomics International, Canoga Park, Calif.).

The recording of SCORE computer program is described. A comparison of the calculated and measured physics parameters for the ZPR-3-48 is presented. (D.C.C.)

23948 (AI-AEC-12744, pp 11-14) FAST-SPECTRUM DOPPLER MEASUREMENTS. Springer, T. H.; Tuttle, R. J.; Royden, H. N. (Atomics International, Canoga Park, Calif.).

The temperature coefficients of reactivity for a series of samples in the ECEL Core 17 are listed. The samples consist of combinations of Th, ^{238}U, ^{235}U, and UO_2. (D.C.C.)

23949 (AI-AEC-12744, pp 15-26) INTEGRAL REACTOR-PHYSICS MEASUREMENTS. Paschall, R. K. (Atomics International, Canoga Park, Calif.).

The neutron spectra for multiple configurations of Na, stainless steel, and Fe-Ni slabs are presented. Intermediate neutron and fast neutron attenuations in the slab configurations are described. The neutron spectra for the ECEL Core 17 are presented for intermediate and fast neutrons. (D.C.C.)

23950 (AI-AEC-12744, pp 31-51) SODIUM FIRE FISSION PRODUCT RELEASE. (Atomics International, Canoga Park, Calif.).

Descriptions of the Spray Test Vessel Test 3 and Test 4 are presented. Experiments involving the arc-vaporization of UO_2 in air performed in the Laboratory Test Chamber are described. A review of the final instrumentation, installation, assembly, and checkout of the Phase 2 test vessel is presented. Recommendations for the improvement of the computer evaluation of a heterogeneous aerosol agglomeration model are discussed. (D.C.C.)

23951 (BNL-13421) SOME COMMENTS ON PSEUDO-MODE SOLUTIONS OF THE INITIAL-VALUE PROBLEM OBTAINED BY ANALYTIC CONTINUATION: THERMAL AND FAST SYSTEMS. Dorning, J.; Nicolaenko, B.; Thurber, J. K. (Brookhaven National Lab., Upton, N. Y.). Jan. 1969. 34p. (CONF-690108-1). Dep. CFSTI.

From Conference on Transport Theory, Blacksburg, Va.

Some of the basic concepts of the method of analytic continuation are presented in detail in the initial discussion of the thermal pulsed-neutron problem. Using analytic continuation, the fundamental root (which bifurcates) of the dispersion relation onto non-physical Riemann sheets is followed. Knowing the locations of these bifurcated roots allows the calculation by saddle point methods of the dominant behavior of the unstable decay state (pseudo-mode). The initial-value problem for subcritical fast multiplying systems is also examined. After reviewing the details of establishing the dispersion relation in terms of the Green's function of an auxiliary slowing-down operator, a solution for that Green's function is presented, and the motion of the root of the resulting dispersion relation on the physical and non-physical sheets is examined. Again, as in the thermal problem, nearby roots (the fundamental root n-furcates) on the sheets adjacent to the physical one allow the calculation of the dominant pseudo-mode decay behavior. The dominant time-behavior when the root is located exactly at the branch point is also obtained by end-point evaluations (Watson's lemma) of the branch integrals. 7 references. (auth)

23952 (BNL-13428) AUTOMATED DATA ACQUISITION AT THE HFBR. Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.). Feb. 28, 1969. 16p. (CONF-690301-1). Dep. CFSTI.
From Conference on Computer Systems in Experimental Nuclear Physics, Skytop, Pa.

Test facilities at the Brookhaven High Flux Beam Reactor are described. Details of the multiple spectrometer control system which is used for automation of neutron experiments, are given. Use of on-line time-shared computers for direct processing of experimental data is discussed; operating experience with these time-shared computers is summarized. Application of the computer-spectrometer system to data acquisition for the various neutron physics studies is outlined. (M.L.S.)

23953 (BNWL-760) PRELIMINARY ANALYSIS OF POSTULATED MAXIMUM ACCIDENTS FOR THE FFTF. Simpson, D. E.; Hagan, J. W.; Waltar, A. E.; Harris, R. A.; Padilla, A.; Fox, G. L. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1968. Contract AT(45-1)-1830. 161p. Dep. CFSTI.

The results of preliminary studies performed to coordinate characteristics and magnitude of a postulated nuclear accident for the Fast Flux Test Facility are presented. The postulated accident is a nuclear excursion which is terminated by core disassembly. The theoretical work energy release resulting from expansion of vaporized core material is concluded to be in the range of 500 to 1500 MW-sec. (H.D.R.)

23954 (BNWL-CC-664) MULTI-NODE SIMULATION OF THE FFTF INTERMEDIATE HEAT EXCHANGER. Gerhardstein, L. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1966. Contract AT(45-1)-1830. 20p. Dep. CFSTI.

A tube and shell counter flow heat exchanger is used in each primary loop of the FFTF Conceptual Design with liquid Na as the primary and secondary coolants. A multi-node model of the intermediate heat exchanger (IHX) was developed and is being used in a four node configuration with the FFTF dynamics analog simulation. A series of tests using 1, 2, 4, and 8 nodes for the IHX simulation indicated that a four-node model will adequately represent the process. (auth)

23955 (BNWL-CC-1704) THE FAST NEUTRON CAVITY EXPERIMENT IN THE PCTR. Preliminary Report. Newman, D. F.; Bennett, C. L.; Stinson, W. P.; Lanning, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 26, 1968. 47p. Dep. CFSTI.

A large Fast Neutron Cavity (FNC) has been constructed and loaded into the central test region of the Physical Constants Test Reactor (PCTR) for an initial experiment to determine the capabilities of the system. The initial experiments were designed to develop the techniques for further use of the FNC with fast reactor fuels and to study effects that may be of interest to future NPTF and FTR neutron energy distribution studies. The work carried out with the FNC was concerned with three main objectives: installation of the FNC and loading enriched uranium fuel in the thermal zone until criticality was achieved; carrying out the necessary safety tests on the reactor to insure compliance with the operating specifications and to gain operational experience; and experimentation with various measuring methods which are intended to be applied for subsequent measurements on fast reactor fuels inserted into the FNC. 7 references. (auth)

23956 (CEA-R-3686) DETERMINATION OF LOCAL BOILING IN LIGHT WATER REACTORS BY CORRELATION OF THE NEUTRON NOISE. Zwingelstein, Gilles (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1968. 58p. (In French). Dep.

The power limit of swimming-pool type reactors depends on the phenomenon of the appearance of burn-out. In order to determine this limit an attempt was made to detect the local boiling which usually occurs before the burn out. Local boiling has been simulated by an electrically heated plate placed in the core of the reactor SILOETTE. The study of local boiling, which is based on the properties of the correlation functions for the neutron noise of detectors placed in the core, shows that a privileged frequency occurs in the power spectrum of the noise. 10 references. (auth)

23957 (DOCKET-50148-2) UNIVERSITY OF KANSAS [RESEARCH REACTOR]. License No. R-78, Amendment 5. (Kansas Univ., Lawrence). Aug. 29, 1967. 50p. Dep. CFSTI.

Changes in the functioning of the Committee on Radiation Sources; Policies and Procedures for the University of Kansas are described. Procedures for treatment of specifically licensed radioactive materials are detailed according to material. Duties and responsibilities of the project supervisor to the Committee are defined. (M.L.S.)

23958 (DOCKET-50184-1) NATIONAL BUREAU OF STANDARDS REACTOR. Final Safety Analysis Report. (National Bureau of Standards, Washington, D. C.). [nd]. 317p. (NBS-8998). Dep. CFSTI.

Information on the NBS Research Reactor is given on the following broad topics: Introduction and Summary; Site Description; Reactor Building and Containment Building; Reactor Core; Primary Coolant System; Secondary Coolant System; Auxiliary Systems; Experimental Facilities and Services; Instrumentation and Control; Shielding; Initial Tests and Operating Procedures; Administrative and Procedural Safeguards; and Safety Analyses. (M.L.S.)

23959 (DOCKET-50184-2) NATIONAL BUREAU OF STANDARDS REACTOR. Final Safety Analysis Report, Suppl. A. (National Bureau of Standards, Washington, D. C.). Oct. 1, 1966. 190p. (NBS-9419). Dep. CFSTI.

The likelihood and consequences of loss of cooling flow, reactivity insertion, loss of electrical power, and loss of instrument and service air accidents are analyzed. Maximum positive reactivity from fuel melting and redistribution is estimated. The containment building and system reliability is evaluated. Test programs to be conducted prior to and following initial fuel loading are described. Operating and emergency procedures are listed. Provisions for protection of personnel are included. Detailed information, including schematics, is presented on the reactor safety system, building isolation system, and the emergency ventilation control systems. Tritium control provisions are discussed, and iodine monitoring procedures are described. The liquid waste automatic monitoring system operation is analyzed. Charcoal filter efficiency and testing procedures are examined. Population zone estimates are updated. Qualifications and experience of reactor personnel are provided. The planned experiment program safety conditions are discussed. (H.D.R.)

23960 (DOCKET-50184-3) NATIONAL BUREAU OF STANDARDS REACTOR. Final Safety Analysis Report, Suppl. B. (National Bureau of Standards, Washington, D. C.). Dec. 16, 1966. 118p. (NBS-9464). Dep. CFSTI.

Efficiency of filters in the emergency exhaust and recirculation systems of the NBS Research Reactor is evaluated. The underground emergency control building is described; personnel safety in the control room following a major accident is analyzed. Details of the containment building control systems and instrumentation are given; schematics of appropriate circuits are included. Consequences of failures in the containment closure system are assessed; experimental values for building pressure and exhaust flow rates are tabulated. Primary system response to reactivity transients is discussed. Shim arm failure probabilities are assessed. Effects of a massive heat exchanger failure are analyzed. Tests of temperature effects on the reactor protective system are outlined. Emergency Core Cooling System design is detailed. Fuel element storage provisions are discussed. (M.L.S.)

23961 (DOCKET-50184-6) [NATIONAL BUREAU OF STANDARDS REACTOR]. ACRS Report. (National Bureau of Standards, Washington, D. C.). Feb. 17, 1967. 3p. Dep. CFSTI.

The ACRS recommendations on the request for an operating license for the NBS Research Reactor are presented. (H.D.R.)

23962 (DOCKET-50184-7) [NATIONAL BUREAU OF STANDARDS REACTOR]. [Amendment to Preliminary Safety Analysis Report]. (National Bureau of Standards, Washington, D. C.). July 25, 1967. 10p. Dep. CFSTI.

Modifications and additions to the safety system are discussed. The safety system circuits, fuel element latch bar assembly, and gaseous effluent monitors are diagrammed. (H.D.R.)

23963 (DOCKET-50184-8) [NATIONAL BUREAU OF STANDARDS REACTOR]: TECHNICAL SPECIFICATIONS. (National Bureau of Standards, Washington, D. C.). 1967. 123p. Dep. CFSTI.

Significant safety limits, functional performance requirements, operating limits, administrative requirements, and surveillance schedules for reactor operation up to 10 MW(t) are presented. (H.D.R.)

23964 (DOCKET-50184-9) NATIONAL BUREAU OF STANDARDS REACTOR. Safety Evaluation by the Division of Reactor Licensing. (National Bureau of Standards, Washington, D. C.). Aug. 14, 1967. 66p. Dep. CFSTI.

Safety aspects of operation to 10 MW(t) are discussed under the following broad topics: site; reactor confinement; reactor core; primary and secondary cooling systems; reactor control and instrumentation; emergency cooling system; fuel element handling and storage; electrical power; waste disposal; experiments; organization; accident analysis; technical specifications; and common defense and security. (H.D.R.)

23965 (DOCKET-50184-10) NATIONAL BUREAU OF STANDARDS REACTOR. Provisional Operating License No. TR-5. (National Bureau of Standards, Washington, D. C.). Nov. 13, 1967. 33p. Dep. CFSTI.

The license authorizing operation to 10 MW(t), the technical specifications, and an estimated schedule of transfers of special nuclear material are presented. (H.D.R.)

23966 (DOCKET-50186-2) UNIVERSITY OF MISSOURI RESEARCH REACTOR: FACILITY LICENSE APPLICATION WITH EXHIBITS B, C, AND D. (Missouri Univ., Columbia). Mar. 1961. 215p. Dep. CFSTI.

An application for both a license to construct the research reactor facility and a license to use special nuclear material required for fuel and the startup source is presented. The financial qualifications of the University, a list of personnel qualified to use the reactor facilities, and a claim for financial protection exemption are included. (H.D.R.)

23967 (DOCKET-50186-3) UNIVERSITY OF MISSOURI [RESEARCH REACTOR]. [Preliminary Hazards Report], Amendment 1. (Missouri Univ., Columbia). July 28, 1961. 60p. Dep. CFSTI.

Information is included on: new site considerations; argon-41 effluent control; reactor containment; and reactor design. (H.D.R.)

23968 (DOCKET-50186-4) UNIVERSITY OF MISSOURI [RESEARCH REACTOR]. [Preliminary Hazards Report], Amendment 2. (Missouri Univ., Columbia). Sept. 29, 1961. 24p. Dep. CFSTI.

Included are: procedures followed in initiating the design and construction of the facility; design contractor qualifications; and architect-engineering firm qualifications. (H.D.R.)

23969 (DOCKET-50186-5) UNIVERSITY OF MISSOURI RESEARCH REACTOR. Annual Report. (Missouri Univ., Columbia) Aug. 1968. 172p. Dep. CFSTI.

The reactor operations to July 31, 1968 are summarized, and experimental activities are listed. License amendments and revisions to the hazards summary report are included. Plant and systems modifications are described. (H.D.R.)

23970 (DOCKET-50186-6) UNIVERSITY OF MISSOURI RESEARCH REACTOR: OSCILLATOR EXPERIMENT. (Missouri Univ., Columbia). Dec. 13, 1968. 34p. Dep. CFSTI.

An analysis and description of a proposed experiment to measure the reactor transfer function using the reactivity oscillator technique are presented. The experiment requires a conditional bypass of the reactor period protection instrumentation. (H.D.R.)

23971 (DOCKET-50186-7) UNIVERSITY OF MISSOURI RESEARCH REACTOR FACILITY. Hazards Summary Report. (Missouri Univ., Columbia). July 1, 1965. 362p. Dep. CFSTI.

Information on the reactor facility is included under the following broad topics: facility description; site; containment system; reactor core; cooling systems; shielding; auxiliary systems; experimental facilities; instrumentation and control; service and maintenance facilities; initial tests and operating procedures; organization and administration; accident analysis. Appendices include: standard operating procedures; general emergency procedures; radiation safety program; and initial staff resumes. (H.D.R.)

23972 (DOCKET-50186-8) UNIVERSITY OF MISSOURI RESEARCH REACTOR FACILITY. Hazards Summary Report, Amendment 1. (Missouri Univ., Columbia). Feb. 1966. 138p. Dep. CFSTI.

Revisions to the original facility license request concerning the inventory of special nuclear material are presented. Detailed answers to 23 questions concerning reactor components and systems design and operation, operating procedures and conditions, containment system design and reliability, and causes and consequences of potential accident conditions are included. (H.D.R.)

23973 (EIR-143) EXPERIMENTAL PHYSICS STUDIES ON D_2O-MODERATED LATTICES OF NATURAL UO_2 CLUSTERS WITH GAS AND H_2O COOLANTS. Heer, W.; Jost, P.; Richmond, R.; Rueegger, B. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Dec. 1968. 59p. Dep.

The results are presented of experimental physics measurements on a series of D_2O-moderated reactor lattices chosen to extend the existing range of information on lattices of this type. The quantities measured were the material buckling, the neutron density fine structure, and the ratio of ^{238}U neutron capture to ^{63}Cu neutron capture in the fuel cluster. The experimental results have been compared, in the first instance, with the predictions of the assessment code METHUSELAH II and it has been shown that this code continues to achieve its aim of providing an assessment tool giving on accuray of 1 to 2% in reactivity predictions. 18 references. (auth)

23974 (ORNL-TM-2527) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, OCTOBER-DECEMBER, 1968. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 42p. Dep. CFSTI.

Operations and maintenance requirements performed for the HFIR during October to December 1968 are presented. Analysis of heat exchanger tube vibration damage and failure is included. (D.C.C.)

23975 (THAI.-AEC-10) CERTAIN ACCOUNTS ON THE UTILIZATION OF THE THAI RESEARCH REACTOR. (Office of Atomic Energy for Peace, Bangkok (Thailand)). 1967. 9p. Dep.

Operations at the Thai Research Reactor during 1962 to 1967 are described. Experimental programs and measurements performed are reviewed. (D.C.C.)

23976 A PRELIMINARY STUDY OF TRITIUM CONCENTRATION IN TSING HUA REACTOR COOLANT. Tsai, C. M.; Weng, P. S. (National Tsing Hua Univ., Hsinchu, Taiwan). Ho Tsu K'o Hsueh, 6: 51-9(Oct. 1968). (In Chinese).

Tritium and other radioactive nuclides have been induced in the Tsing Hua Open-pool Reactor (THOR) coolant by the exposure of minute amounts of deuterium and impurities existing in the coolant water to the neutrons after some 6,000,000 kWh operation. A mixed bed resin was traced by the tritium and the fission product standard sources and then passed through by the coolant sample of which 3 milliliters were dissolved in the liquid scintillator. With an aid of a liquid scintillation counter the tritium content was found to be $5.74 \times 10^3 \pm 2.1\%$ T.U. The reactor power output can be estimated from the tritium activity, particularly under long time and high power operation. 11 references. (auth)

23977 A SAFETY STUDY IN PERIODICALLY OPERATED LOW POWER RESEARCH REACTOR. Yang, Teh-li (National Tsing Hua Univ., Hsinchu, Taiwan). Ho Tsu K'o Hsueh, 6: 39-50(Oct. 1968).

In safeguards reports for research reactors the estimation of built-in reactivity and fission product inventory is based on continuous operation in spite of the fact that the reactor may be operated a few hours a day and 5 days a week. Six hours are taken as an average daily operation time. The estimated built-in reactivity, excluding experiment, will be 1.27% $\Delta k/k$ instead of 2.7% $\Delta k/k$ for one month continuous operation at 1 MW. The estimated radiation effect of iodine, the controlling isotope, will be about 10% of that for continuous operation. The maximum credible accident considered in some safeguards reports is reviewed, and its feasibility is discussed. 12 references. (auth)

23978 THE USE OF AN ON-LINE COMPUTER IN THE SOLUTION OF NOVEL INSTRUMENTATION PROBLEMS ON PULSED AND STEADY STATE NUCLEAR REACTORS. Weale, J. W. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Benjamin, P. W. pp 120-7 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The Nuclear Assemblies Division at Aldermaston operates two experimental fast reactors: one, named VERA, is a low power steady state reactor; the other, named VIPER is a pulsed reactor. The requirement for accurate measurements of the neutronic properties of these reactors led to the development of new instrumentation systems involving the on-line application of a small digital computer. In the pulsed reactor work a system was developed to measure the time variation of the reactor power, the fuel temperature and the fuel expansion during pulses which rise from a power of 10 kW to 20,000 MW in 1 or 2 msec. For the low-power reactor a system was developed to classify the pulses from a proportional counter according to total energy and rate-of-rise and then to use the results to determine the neutron energy spectrum in the reactor. The instrumentation systems which have been developed to fulfill these requirements and the essential part played by the on-line computer are described. (auth)(UK)

23979 COMPUTER CONTROL OF NEUTRON BEAM EXPERIMENTS. Maslin, E. E. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 104-7 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

A 5 MW research reactor, HERALD, is used in a programme of measurements in nuclear physics and neutron physics. A PDP-8 computer, with magnetic tape backing storage and display facilities, is used to analyze the data from experiments in fission physics, from neutron scattering measurements, and also to perform automatic control and data collecting functions for a neutron crystal diffractometer. A total of four experiments can be operating simultaneously and independently. The system that was developed provides flexibility by storing most of the programs on the magnetic tape backing storage. It allows the experiments to be operated concurrently by functioning in a multiprocessing mode in which any experiment can interrupt the computer and be serviced with the minimum of delay. It offers the experimenter many facilities for handling data which could not have been made available without the use of a computer. (auth)(UK)

23980 STATIC AND DYNAMIC HYDROELASTIC INSTABILITIES IN MTR-TYPE FUEL ELEMENTS. PART II. THEORETICAL INVESTIGATION AND DISCUSSION. Smissaert, Georges E. (Pennsylvania State Univ., University Park). Nucl. Eng. Design, 9: 105-22(Jan. 1969).

Static deflections and flutter-like vibrations in flat-plate nuclear reactor fuel assemblies are analyzed. Self-excited hydroelastic instabilities in an infinite plate array, in which a high-density fluid flows through the narrow channels between the plates, can be of the class A, B or C type. Extrapolation of the theory to a real fuel element identifies small-amplitude traveling waves as class B instabilities. The physical meaning of the Miller's velocity is shown to be that of a static divergence in the plate array for inviscid flow. Plate flutter or large-amplitude vibration originates from a coupling between class B and leading-edge instabilities. The class B instability has a low threshold velocity but this instability is a mild one. The flutter, however, does not occur below a minimum velocity which is approximately twice the Miller's velocity. It is explained why a support comb at the leading edge is an effective means to prevent flutter. Comparison between theory and experiment confirms the validity of the analysis. (16 references) (auth)

23981 APPLICATIONS OF TIME-SHARING COMPUTERS TO REACTOR PROBLEMS AND SIMULATION OF TRIGA REACTOR PULSES. Robinson, Alan H.; Upham, Gary L. (Oregon State Univ., Corvallis). Simulation, 11: 203-6(Oct. 1968).

The use of the time-sharing system may be divided into 3 categories: simulation programs, instructional programs, and research programs. The technical specifications for loading the TRIGA reactor in Corvallis contain instructions to be followed at each step and tests to be performed. The computation work involved and compliance with the instructions in the fuel-loading process can be greatly simplified by using a program that will read in the data after each step, perform the calculations involved, and print out the appropriate steps to be performed next. The present program is a limited one because it does not perform the calculations. It does, however, contain the instructions for the steps to be performed. The physical systems for operation of the reactor in the pulsing mode were simulated using the Fuchs–Nordheim model for reactor kinetics. The basic assumptions of the model neglect the effect of the delayed neutrons and neglect the heat transfer to the reactor coolant. Differential equations were solved simultaneously using the four-point Runge–Kutta formulas. Typical run-times for the code were 25 sec. The input parameters for the code were the initial power and temperature and the reactivity insertion. Calculation results are highly dependent upon the constants used. These parameters were estimated from values from the literature, and may introduce some errors in the results. (BBB)

23982 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Gulf General Atomic Inc.). British Patent 1,148,610. Apr. 16, 1969. Priority date Sept. 30, 1965, United States.

REACTOR FUEL ELEMENTS—description of swimming-pool pulsed reactor sealed cylindrical graphite reflected nitrogen insulated
REACTORS, RESEARCH—fuel elements for pulsed swimming-pool, description of sealed cylindrical graphite reflected nitrogen insulated
REACTORS, SWIMMING-POOL—fuel elements for pulsed, description of sealed cylindrical graphite reflected nitrogen insulated (D.C.C.)

23983 SEMIEMPIRICAL FORMULA FOR ALBEDO OF ALTERNATING LAYERS. Nakamura, Takashi; Hyodo, Tomonori (Kyoto Univ.). Nucl. Sci. Eng., 36: 246-50(May 1969).

A semiempirical formula for the gamma-ray albedo of alternating layers is proposed. The values of the albedo calculated by this formula agree with the experimental ones for alternating layers of tin–aluminum and lead–aluminum slabs within ~10%, except for the case of very thin alternating layers. This formula was applied to the angular distribution of photons backscattered by the alternating layers and the difference between experimental and calculated values was <18%. 14 references. (auth)

23984 MEASUREMENTS OF NONFISSION HEATING IN A HIGH NEUTRON FLUX REACTOR. Carroll, R. M.; Perez, R. B.; Sisman, O. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 36: 232-7(May 1969).

The nonfission (NF) heating and thermal-neutron flux were measured in copper as a function of distance from the core center line of the ORR Reactor at different times of a reactor cycle. Above the core, the NF heating is a linear function of the thermal-neutron flux ϕ expressed by NF heating (W/g) = $(8.73 \times 10^{-14})\phi + 0.09$. Within the core the relation between the measured thermal-neutron flux and the NF heating is influenced by other factors. 5 references. (auth)

Rocket and Space Reactors

Refer also to abstracts 22519 and 23942.

23985 (N-68-36055) HIGH POWER KINETICS OF A TWO DIMENSIONAL CIRCULATING LIQUID METAL FUEL REACTOR. Kolar, Michael J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct. 1968. 54p. (NASA-TN-D-4840). CFSTI.

A two dimensional model of a single channel unreflected circulating fuel reactor is used to investigate the effect of a radial temperature distribution on the neutron kinetics. A slug flow model with no delayed neutrons is used. The effects of a nonuniform radial heat source distribution and radial heat transfer are taken into account. Results show that radial heat transfer has little effect on the kinetics. Furthermore, if changes in multiplication are not too large, the flux and radial temperature distribution maintain their steady state shapes throughout the transient. For certain combinations of the physical parameters, resonances can occur in the time dependent flux and temperature. These resonances can be predicted by either a line reactor model or a two dimensional reactor model; however, a two dimensional model is necessary to predict the value of the steady state flux and temperature following a transient. (auth) (STAR)

23986 (N-68-36412) A STUDY OF FLUID DYNAMICS OF GASEOUS NUCLEAR ROCKETS. Quarterly Progress Report, July 1–September 30, 1968. Lewellen, W. S. (Massachusetts Inst. of Tech., Cambridge). Sept. 30, 1968. Contract NSR-22-009-288. 18p. (NASA-CR-97113; QPR-2). CFSTI.

Empirical correlations were made of experimental data found in the available literature in order to provide the information required to predict the flow pattern in any given vortex tube. When laminar flow theory was compared with experimentally obtained velocity profiles, the resultant curves were found to be in close agreement; and differences between theory and experiment were attributed to the turbulence for the high Reynolds number experiments. Ratio of effective eddy viscosity to actual laminar velocity was also plotted, and the slight differences were attributed to turbulance as well as to approximation used in making calculations. (STAR)

23987 (N-68-36615) EXPERIMENTAL STUDY OF MULTICOMPONENT COAXIAL-FLOW JETS IN SHORT CHAMBERS. Johnson, Bruce V. (United Aircraft Corp., East Hartford, Conn.). Oct. 1968. Contract NASw-847. 84p. (NASA-CR-1190; G-910091-16). CFSTI.

Fluid mechanics experiments were performed to obtain information applicable to an open cycle, coaxial flow, gaseous nuclear rocket engine. In this engine concept, gaseous nuclear fuel and a surrounding stream of seeded hydrogen propellant pass coaxially through a reactor chamber. The flow was simulated by multicomponent, constant temperature, coaxial flow jets in short chambers. The flow was studied using flow visualization techniques and concentration measurements. (auth) (STAR)

23988 (N-68-37209) VERY HIGH BURNUP VAPOR TRANSPORT FUEL PIN CONCEPT FOR LONG LIFE NUCLEAR REACTORS. Rom, Frank E.; Finnegan, Patrick M.; McDonald, Glen E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct. 1968. 33p. (NASA-TN-D-4860). CFSTI.

A very-high-burnup, vapor-transport fuel-pin concept is presented. Sample calculations using the design charts given in the report show that fission densities in the range of 10^{20} to 10^{21} fissions per cubic centimeter are conservatively predicted. The fuel within the pin can be operated at sufficiently high inside surface temperatures so that fuel redistribution will occur by design. This feature accommodates and relieves the adverse effects of nonuniform power distribution, hot spots, and nonuniform burnup. Changes in reactor reactivity due to high burnup are minimized with the vapor-transport fuel-pin concept. (auth) (STAR)

23989 (WANL-TME-1752) GAMBIT PROGRAM. Collier, George; Gibson, Gordon (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Apr. 1968. Subcontract NP-1. 87p. Dep. CFSTI.

GAMBIT is a FORTRAN IV program that provides broad-group flux and current averaged neutron cross sections. They are based on a thermal cross section library consisting of 99 fine groups (0 to 2.38 eV), and a fast-neutron library consisting of 68 fine groups (0.414 eV to 10 MeV, $\frac{1}{4}$ lethargy intervals). The fluxes and currents required to obtain the broad-group cross sections may be calculated with GAMBIT or may be entered into the program. In addition a Maxwellian spectrum may be used in the thermal range. If the flux is calculated, either the B1 or P1 method of solving the transport equation may be used. In effect the steady state transport equation is solved for an infinite medium problem. The program provides cross sections for a full P(1) transport calculation; cards are punched out in a format suitable for input to the ANISN and DOT discrete-ordinates transport codes. The manner in which BIT (thermal code) is linked to GAM (high-energy code) is described as well as the thermal code BIT. The GAM code is documented. (auth)

23990 A LOW-POWER THERMIONIC REACTOR WITH EXTERNALLY ARRANGED CONVERTERS AND COLLECTOR COOLING BY HEAT PIPES. Dagbjartsson, S.; Groll, M.; Zimmermann, P. (Univ., Stuttgart). Raumfahrtforschung, 13: 24-7(Jan.-Feb. 1969). (In German).

The design of a fast thermionic reactor as a power source for spacecraft is presented. Planar Cs converters are arranged around the cylindrical core. The emitters are heated by heat radiation from the core surface. The collectors are cooled by means of heat pipes. A beryllium reflector is attached to the converter section and leads to the desired power flattening in the axial direction. A part of the radial reflector is used for reactor control. The design of the power plant and some problems of the series-parallel connections of the converters are discussed. A survey of methods and results of the computations is given. The plant can be operated in a region below 15 kW. The respective mass is about 260 kg (shielding not included). The plant is characterized by simple structure and high reliability. 6 references. (auth)

Process Heat and Desalination Reactors

23991 (ORNL-TM-2547) INVESTIGATION OF THE FEASIBILITY OF PURIFYING MUNICIPAL WASTE WATER BY DISTILLATION. Spiewak, I. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 43p. Dep. CFSTI.

The feasibility of nuclear power plants for the provision of low cost thermal energy to urban areas for purifying municipal waste water by distillation for reuse and as a step in the ultimate disposal of solids was studied. The technical problems of waste water distillation, described in the literature, are summarized. Cost estimates are given for a number of possible systems using distillation to treat effluent from a city of 1 million population. The analysis indicates that, although advanced waste treatments may increase the cost of sewage processing by factors of up to four times, the overall cost of water supply and treatment need not be increased over about 50%. Distillation appears to be a promising method of waste treatment, although methods of controlling tube fouling and distillate quality remain to be developed. (auth)

23992 (ORNL-TM-2550) ABSTRACTS OF PAPERS, WATER AND DESALINATION INFORMATION MEETING, MAY 12-13, 1969. Kraus, K. A.; Hammond, R. P. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 54p. Dep. CFSTI.

Abstracts of 15 papers concerning water research and nuclear desalination are presented. (D.C.C.)

Marine and Portable Power Reactors

23993 FIRST NUCLEAR SHIP OF JAPAN. Ishikawajima-Harima Giho, 9: 7-24(Jan. 1969). (In Japanese).

The many features of the ship, including those incorporated to enhance the safety aspects of nuclear ship operation, are described. (auth) (NSA of Japan)

Production Reactors

23994 (DUN-M-2) EMERGENCY PROCEDURES MANUAL. (Douglas United Nuclear, Inc., Richland, Wash.). [1968]. 208p. Dep. CFSTI.

Important actions to be taken during the first few minutes of emergency events at Douglas United Nuclear facilities are summarized. Events discussed include: loss of coolant in a reactor; fire; exreactor criticality and uncontained irradiated fuel elements; chlorine escapement; and multicurie shipment accidents. (H.D.R.)

Reactor Theory

Refer also to abstracts 23607, 23918, and 23951.

23995 (AAEC/TM-489) SOME METHODS OF CALCULATING FIRST FLIGHT COLLISION PROBABILITIES IN SLAB AND CYLINDRICAL LATTICES. Doherty, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan. 1969. 21p. Dep.

A number of methods of calculating collision probabilities in slab and cylindrical geometry have been programmed in Fortran for the IBM 360/50H computer. They are intended to provide a set of rapid subroutines suitable for incorporation in a heterogeneous resonance absorption program when the subroutine will be called 10^5 times per run. Some of the methods presented are too slow for such an application but they provide useful checks on the more rapid methods and could be suitable for a few-group neutron transport calculation. (auth) (Australia)

23996 (BARC-371) INTEGRATION OF THE POINT-REACTOR KINETIC EQUATIONS WITH A PERIODIC REACTIVITY INPUT BY USE OF QUASI-PERIODIC VECTOR SOLUTIONS. Trasi, M. S. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 9p. Dep.

It is shown that the complete reactor response to a periodic reactivity input can be obtained by studying the response over an interval of time whose length is equal to (m + 1) times the period of the input reactivity, where m is the number of delayed neutron groups, and making use of the properties of linearly independent quasi-periodic vector solutions of the kinetic equations with periodic coefficients. These vector solutions exist subject to certain conditions which are generally satisfied. As an example, this method is applied to the case where the delayed neutrons are represented by a single group, and a sinusoidal reactivity is fed in. (auth)

23997 (EIR-144) PETRAX: A PROGRAM FOR CALCULATING THE FLUX IN CELLS WITH AXIALLY VARIABLE PARAMETERS. Burnand, G.; Juillerat, T. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Dec. 1968. 30p. Dep.

PETRAX is a FORTRAN program designed to calculate the radial and axial flux distribution in a cell of finite height, consisting of a series of concentric shells whose neutronic properties vary in the axial direction. The main characteristics of the program are: the flux is a solution of the P_3 approximation to the stationary transport equation; only a single energy group of neutrons is considered; an isotropic external source radially constant in each zone is specified; neutrons are reflected from the outer radial boundary of the cell; and the scattering cross-section is assumed to be linearly anisotropic. (auth)

23998 (KAPL-P-3803) VARIATIONAL METHODS AND NEUTRON FLUX SYNTHESIS. Wachspress, E. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 13, 1969. 25p. (CONF-690401-1). Dep. CFSTI.

From Conference on the Effective Use of Computers in the Nuclear Industry, Knoxville, Tenn.

A review of synthesis techniques for calculating neutron fluxes in a reactor is given. Methods of selecting base functions for synthesis computations in the time domain are described; mathematical properties of these base functions are outlined. Methods of choosing the combining functions for definition of the functional are prescribed; criteria for and constraints on these choices are delineated. The concept of the trial function is explained; its role in synthesis computations is defined. The variational formalism is developed for direct and adjoint applications. Variational equations are constructed for discrete multigroup diffusion problems; error approximations are included. Application of the variational equations to spatial synthesis of the thermal spectrum problem is discussed. The method of discontinuous trial functions for multichannel synthesis formulation is detailed. 42 references. (M.L.S.)

23999 (WAPD-TM-771) EXTREMIUM VARIATIONAL PRINCIPLES FOR THE MONOENERGETIC TRANSPORT EQUATION WITH ARBITRARY ADJOINT SOURCE (LWBR DEVELOPMENT PROGRAM). Buslik, A. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1969. Contract AT-11-1-GEN-14. 45p. Dep. CFSTI.

A variational method is given for determining the lower and upper bounds for the monoenergetic transport equation with arbitrary adjoint source. The functional is chosen as a form of the one-velocity Boltzmann transport equation; spherical harmonics expansions are used as trial functions. Three types of boundary conditions (b.c.) are considered: vacuum b.c., symmetric b.c., and antisymmetric b.c. Mathematical properties of the functional are deduced; stationarity criteria are applied to the functional for all three types of boundary conditions. Lower and upper bounds are obtained for the functional. A numerical example is included. 18 references. (M.L.S.)

24000 (WAPD-TM-806) NOWIG: A PROGRAM TO SOLVE THE POINT KINETICS APPROXIMATION TO THE ONE-DIMENSIONAL, TWO-GROUP DIFFUSION EQUATIONS WITH TEMPERATURE FEEDBACK. Yasinsky, J. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1969. Contract AT-11-1-GEN-14. 34p. Dep. CFSTI.

NØWIG is a computer program for solving the one-dimensional two-group neutron diffusion and delayed precursor equations within a shape-specified point kinetics approximation. Feedback due to changes in the regionwise constant fuel metal temperature and coolant density is accounted for using a model which is identical with that used in the WIGL2 program. NØWIG is meant to be a companion tool with WIGL2 or WIGL3 which will permit determination of errors inherent in neglecting flux shape changes for dynamic problems with temperature feedback. The governing equations, solution techniques, and input information are included. (auth)

24001 INTEGRODIFFERENTIAL EQUATIONS OF A CLASS OF NUCLEAR REACTORS WITH DELAYED NEUTRONS. **Levin, J. J.; Nohel, J. A. Arch. Ration. Mech. Anal., 31: 151-72(Nov. 14, 1968).**

Equations previously developed describe the dynamic behavior of a continuous medium nuclear reactor modeled as a doubly infinite rod. They do not take into account the important effect of delayed neutrons. For reactor systems modeled by ordinary differential equations this effect has been studied. The effect of delayed neutrons is now added to the integrodifferential equations and conditions are obtained which ensure the global asymptotic stability of the system, as a theorem. If the effect of delayed neutrons is neglected, a corollary of the theorem is found as a new result for the system. Since an actual reactor is not infinite, it is more realistic to replace the infinite integral by a finite one. It is then necessary to impose appropriate boundary conditions on the temperature. Two such cases are considered, both of which also include the effect of delayed neutrons. Previous studies of a special case without delayed neutrons are cited. (BBB)

24002 EFFECTS OF ANISOTROPIC HOLE SYSTEMS ON THE NEUTRON STREAMING IN A MODERATOR. I. **Sekiya, Tamotsu; Takeda, Toshikazu. Technol. Rep. Osaka Univ., 18: 303-7(Oct. 1968).**

The method which has been developed to evaluate the second spatial moments of neutron distribution in isotropic hydrogeneous moderators containing random voids is generalized to treat anisotropic hole systems which usually occur in heterogeneous lattice systems in practical nuclear reactors. The theory from the isotropic case to the anisotropic one is generalized and also a new way to calculate angular correlations of two free path lengths at different lethargies is presented. The correlation function is given by the solution of simultaneous integral equations. 15 references. (auth)

24003 A THREE-DIMENSIONAL MULTIGROUP P_L-THEORY WITH AXIALLY VARIABLE PARAMETERS. Juillerat, T. (Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Nukleonik, 12: 117-24(Mar. 1969).

The stationary integro-differential Boltzmann equation is solved in r-θ-z geometry for a medium of finite height, consisting of concentric annular regions. All zones may be multiplying and neutronic parameters may vary in the axial direction. The energy dependence is treated by means of multigroup theory, the angular dependence is described by a development into spherical harmonics (P_L-method), and the azimuthal and axial variations are obtained by a development into Fourier series. The radial variation, given by the solution of a system of coupled differential equations derived from the Boltzmann equation, is obtained by means of Lie series. The theory is applicable to cell calculations for boiling water reactors, and to the treatment of irradiated fuel or of gaps and spacers between sections of fuel rods. An application of P_3-theory to the latter problem will be illustrated and shown to be in good agreement with experiment. 14 references. (auth)

24004 A MATHEMATICAL MODEL FOR THE DYNAMIC BEHAVIOUR OF A POWER REACTOR WITH PARTICULAR REGARD TO NON-STATIONARY HEAT TRANSFER. **Palinski, R. (EURATOM, Ispra, Italy). Nukleonik, 12: 134-42(Mar. 1969).**

A model to treat the dynamics of reactors with slab-type fuel elements is presented. The partial differential equations governing the time-dependent heat withdrawal from the fuel are prepared by means of Laplace transformation methods so as to give a set of ordinary differential equations which are easily treatable on analog computers. The method is useful whenever the neutron kinetics equations are to be solved by an analog computer and the thermal feedback reactivity, originally described by partial differential equations, has to be calculated simultaneously. (auth)

24005 DIFFUSION LENGTHS IN HETEROGENEOUS, NON-MULTIPLYING ASSEMBLIES. **Williams, M. M. R.** (London Univ.). **Nukleonik, 12: 129-34(Mar. 1969).**

An integral equation for the spatial decay constant in a medium of arbitrarily heterogeneous cross section is derived. It is shown that the decay constant is bounded by the minimum value of the total cross section in the lattice. The existence of the decay constant (eigenvalue) as a function of the area of the cross section is studied, and it is found that for a sufficiently small area the eigenvalue ceases to exist. We also derive explicitly a pair of coupled integral equations for a two-component slab lattice, which constitute an eigenvalue problem for the decay constant parallel to the slabs. A method for solving these equations is proposed and equations that will lead to the necessary conditions of slab thickness for the existence of a decay constant are derived. 10 references. (auth)

24006 CALCULATION OF RESONANCE INTERACTION EFFECTS USING A RATIONAL APPROXIMATION TO THE SYMMETRIC RESONANCE LINE SHAPE FUNCTION. **Haeggblom, H. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nukleonik, 12: 97-109(Mar. 1969).**

The method of calculating the resonance interaction effect by series expansions has been studied. Starting from the assumption that the neutron flux in a homogeneous mixture is inversely proportional to the cross section, the expression for the flux can be simplified by series expansions. Two types of expansions are investigated and it is shown that only one of them is generally applicable. It is also shown that this expansion gives sufficient accuracy if the approximate resonance line shape function is reasonably representative. An investigation is made of the approximation of the resonance shape function with a Gaussian function which in some cases has been used to calculate the interaction effect. It is shown that this approximation is not sufficiently accurate in all cases which can occur in practice. Then, a rational approximation is introduced which in the first order approximation gives the same order of accuracy as a practically exact shape function. The integrations can be made analytically in the complex plane and the method is therefore very fast compared to purely numerical integrations. The method can be applied both to statistically correlated and uncorrelated resonances. 12 references. (auth)

24007 APPLICABILITY OF THE REACTOR KINETIC PHENOMENA FOR THE REACTIVITY DETERMINATION. **Chwarszczewski, S. (Inst. of Nuclear Research, Swierk, Poland). Nukleonik, 12: 75-9 (Jan. 1969).**

The possibility of determination of the static reactivity applying the analysis of the reactor kinetic parameters was considered. Based on general properties of the solutions of the equations describing time independent and time dependent neutron flux the criterion of the static reactivity concept application for the reactor kinetic description is derived. Using this criterion the analysis of the kinetic methods for reactivity determination was performed. 15 references. (auth)

24008 NEW PERTURBATION METHOD FOR COUPLED REACTORS. **Gandini, A.; Salvatores, M. (CNEN, Rome). Nukleonik, 12: 80-3 (Jan. 1969).**

New perturbative methods are applied to the integral quantities which appear in Avery's formulation for multipoint analysis of coupled reactors. Simple formulations are derived for changes of the coupling coefficients and coupling neutron life-times consequent to perturbations of the system. A numerical example relevant to a large reference design shows their applicability to modular systems. 9 references. (auth)

24009 LINEAR EXTRAPOLATION DISTANCE AT A FREE SURFACE WITH CONVEX CURVATURE. **Pomraning, G. C. (Los Alamos Scientific Lab., N. Mex.). Nukleonik, 12: 92-3 (Jan. 1969).**

Neutron transport in a source-free homogeneous medium is bounded at least partially by a free surface; that is, no neutrons enter the medium through this surface. The neutron transport is described by the steady-state monoenergetic transport equation with isotropic scattering. In such a situation it is well known that the scalar flux contains an asymptotic component which falls off as one approaches the free surface. The linear extrapolation distance is defined as the reciprocal of the logarithmic derivative, with respect to an inward normal, of this asymptotic flux at the free surface. An approximate expression for the extrapolation distance at free surfaces with convex curvature is derived. 21 references. (auth)

24010 EXACT SOLUTION OF THE NON-LINEAR PROMPT KINETICS EQUATIONS. A BENCHMARK PROBLEM IN REACTOR KINETICS. **Froehlich, R.; Johnson, S. R. (Gulf General Atomic Inc., San Diego, Calif.). Nukleonik, 12: 93-6 (Jan. 1969).**

The point reactor kinetics equations with ramp insertion of reactivity, linear temperature feedback and constant power removal are solved exactly. Explicit formulas, figures and tables are presented which give the following physical quantities for each realistic problem after some very simple hand calculations: maximum power, period of power oscillation, temperature change during one period, maximum reactivity, and if desired, the time dependent power, temperature, and reactivity. The qualitative dependence of maximum power density, period, temperature increase, etc., on the original physical parameters is discussed. 11 references. (auth)

24011 A GENERALIZATION OF THE FINITE DIFFERENCE APPROXIMATION TECHNIQUE APPLIED TO A NODAL MODEL OF SPACE-DEPENDENT NUCLEAR REACTOR KINETICS. **Alcouffe, Raymond Edmond. Seattle, Univ. of Washington, 1968. 162p.**

Thesis.

A nodal approximation of the time-dependent, one dimensional neutron diffusion equation including the effects of delayed neutrons and simple temperature feedback, has been developed. This approximation is based on a generalization of the conventional finite difference technique in that one is able to supply information of this technique about the expected solution in addition to a boundary and initial condition. The approximation is derived from a variational principle and is, therefore, consistent with the previously derived synthesis method and may be viewed as a subclass of such a method. The attributes of the particular method developed are described. (Disser. Abstr.)

24012 TIME-ENERGY-DEPENDENT NEUTRON TRANSPORT IN AN INFINITE MEDIUM IN THE FRAMEWORK OF AGE-DEPENDENT BRANCHING PROCESSES. **Waelti, P. (Federal Inst. of Tech., Zurich). Nucl. Sci. Eng., 36: 133-42 (May 1969).**

The mathematical model of age-dependent branching processes is used to describe neutron slowing down and multiplication in an infinite medium. To construct the probability measure of the neutron branching process, it is necessary to determine the probability density $\bar{n}(E,\theta)$ for a neutron of age θ(= time elapsed since birth of the fission neutron) to have energy E. This problem, which is equivalent to the time-dependent slowing down problem, is solved for a scattering law of the form $\nu(E)\Sigma_s(E \rightarrow E')dE' = aE^{\mu}h(E'/E)\ (dE'/E)$ and an absorption cross section satisfying the relation $\nu(E)\ \Sigma_a(E) = bE^{\mu} + c$. In this case, it is proved that there always exist particular "invariant" probability densities $\bar{n}(E,\theta)$ suffering only contraction during ageing, i.e., having the form $\bar{n}(E,\theta) = m(E/E_{\theta})\ (1/E_{\theta})$. For the time-dependent slowing down problem with a Greuling–Goertzel kernel, the results are compared with those of Koppel. Particular attention is paid to stationary energy spectra. 17 references. (auth)

Experimental Applications

Refer also to abstracts 23945 and 23983.

24013 A MULTIGROUP FORMALISM FOR THE ANALYSIS OF THE DOPPLER ACTIVATION EXPERIMENT. **Beynon, T. D. (Univ. of Birmingham, Eng.). Nukleonik, 12: 62-7 (Jan. 1969).**

A multigroup energy formalism is presented for the analysis of the ^{238}U-sample activation experiment in fast reactors. It is found that, for the purpose of calculating reaction rates, the Doppler fine structure in the energy dependence of the neutron flux impinging on the sample can be adequately represented by energy-group averages. A preliminary analysis is made of a series of recent activation measurements and the validity of the method is demonstrated. It is noticed that the activation ratio in such experiments can be considerably more sensitive to the positioning of the sample in the core than to quite large variations in ^{238}U cross section data. 17 references. (auth)

24014 EXPERIMENTAL NEUTRON KINETIC STUDIES IN A ^{238}U SPHERE. **Gozani, Tsahi (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 36: 143-58 (May 1969).**

A detailed experimental study on the kinetics of a ^{238}U sphere is described. The measurements involve the use of nanosecond electronics and silicon solid-state detector with two fission conversion foils: ^{235}U and ^{237}Np. Thus, some information on the time-energy coupling was obtained. The results show a nonexponential behavior over all time ranges. At longer times, the space and time coupling was small. At early times, the coupling between energy space and time was strong. The early time behavior of the high-energy neutrons (above ^{237}Np threshold) appears to be exponential. The decay constant, however, is a function of position. It is shown that this exponential behavior is a result of a "pseudo-trapping" of neutrons between the fast fission threshold in ^{237}Np and the large step in the inelastic scattering cross section of ^{238}U. 11 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 21877, 21885, 21926, 22033, 22034, 22136, 22454, 22459, 22460, 22501, 22502, 22578, 22619, 22645, 22666, 22690, 22698, 23671, 23848, and 23936.

24015 (AI-AEC-12744, pp 61-4) COOLANT MANAGEMENT. **Murbach, E. W.; Atkins, D. F. (Atomics International, Canoga Park, Calif.).**

Test results for a new oxygen meter electrode in a sodium loop are presented. (D.C.C.)

24016 (AI-AEC-12744, pp 183-9) NOISE ANALYSIS INSTRUMENTATION. **Randall, R. L. (Atomics International, Canoga Park, Calif.).**

Test results for a 2 inch diameter water loop with conductivity sensors at five axial locations and thermocouples at two radial and two axial locations are described. Results indicate that the factor relating measured transit rate to average flow velocity for each pair of sensors is independent of temperature, flow conditions, injection methods, and that it is constant. (D.C.C.)

24017 (CONF-680821-, pp 56-64) MOISTURE SEPARATORS. **Peters, A. H. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).**

The function, features, and testing recommendations for moisture separators in reactor containment applications are described. 6 references. (auth)

24018 (CONF-680821–, pp 65-78) FILTERS: PREFILTERS, HIGH CAPACITY FILTERS, AND HIGH EFFICIENCY FILTERS; REVIEW AND PROJECTION. First, Melvin W. (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab. Harvard School of Public Health, Boston, Mass.).

A review of the development of aerosol filters is presented. The use of aerosol filters in reactor containment systems is described. 18 references. (D.C.C.)

24019 (CONF-680821–, pp 79-85) GOVERNMENT-INDUSTRY MEETING ON FILTER MEDIA AND MEDIA TESTING. Anderson, W. L. (Naval Research Lab., Washington, D. C.).

The physical and performance characteristics of 27 aerosol filter materials included in the basic weight comparison for reactor containment systems are listed. (D.C.C.)

24020 (CONF-680821–, pp 86-108) REDEVELOPMENT OF THE SAVANNAH RIVER LABORATORY MOISTURE RESISTANCE TEST FOR FILTER PAPER. Schwalbe, H. C. (Herty Foundation, Savannah, Ga.).

Important users of HEPA filter media for reactor containment specify exposure of filter media for 10 days to a steam-air mixture to assure freedom from breaks in the media in actual filter installations. This test was found to be superior to the current water repellency test adopted in 1956. A redeveloped test of 2 hours duration in an apparatus modified by the Savannah River Laboratory is described. A new method to assess changes in elasticity was introduced. Two transducers of the Sonic Modulus Tester are mounted on the inside of the exposure chamber and contact the filter media. 20 references. (auth)

24021 (CONF-680821–, pp 109-47) FACTORS INFLUENCING HIGH EFFICIENCY FILTER GASKET LEAKAGE. Adley, F. E.; Sims, L. L. (Hanford Environmental Health Foundation, Richland, Wash. Environmental Health Sciences Dept.).

Data are presented on the performance of molded polyvinyl chloride HEPA filter gaskets. Tests show their overall performance poorer than the closed-cell neoprene gaskets presently in use. The molded gaskets do not seal adequately around defects in mounting surfaces. They also have a tendency to deform permanently by shearing at compressions above 35%. Recommendations are made for specifying HEPA filter gaskets. (auth)

24022 (CONF-680821–, pp 149-66) ADSORBENTS: REVIEW AND PROJECTION. Kovach, J. Louis (North American Carbon, Inc., Columbus, Ohio).

The method of iodine removal by absorbents depends on both the chemical and physical properties of the iodine compound and the chemical and physical properties of the absorbent employed. A review of gas-solid interactions is presented. Parameters influencing the iodine removal efficiency of adsorbents are described. 28 references. (auth)

24023 (CONF-680821–, pp 167-9) CHARCOAL POST TREATMENT; HEAT DEGRADATION AND SERVICE LIFE. Milham, R. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

The performance of Type 416 and Type 592 carbon in the Savannah River Plant containment system is described. The effects of service, temperature, face velocity, iodine loading, impregnation, and partial regeneration on carbon performance are analyzed. (D.C.C.)

24024 (CONF-680821–, pp 170-84) AGING AND WEATHERING OF IMPREGNATED CHARCOALS USED FOR TRAPPING RADIOIODINE. An Interim Report. Ackley, R. D.; Adams, R. E. (Oak Ridge National Lab., Tenn.).

Aging, weathering (exposure to flowing air), and poisoning are processes which might adversely affect charcoal performance, especially with regard to trapping radioiodine in the form of methyl iodine (CH_3I). Accordingly, some effort has been applied toward investigating the effects of the above processes. The bulk of the data thus far obtained correspond to three different types of charcoal. Two types are iodized, to provide isotopic exchange capability, and the other is triethylenediamine-impregnated. The influences of the processes were examined by observing the variation in ^{131}I of $CH_3{}^{131}I$ removal capability for the iodized charcoals or in CH_3I removal capability for the amine-impregnated charcoal. The results, which were generally in accord with expectation, indicated the following: aging per se has little or no effect on impregnated charcoal performance; weathering with air at around 50% relative humidity has an appreciable effect; and poisoning of iodized charcoal can have a large effect. (auth)

24025 (CONF-680821–, pp 185-203) HIGHLY EFFICIENT INORGANIC ADSORBER FOR AIRBORNE IODINE SPECIES (SILVER ZEOLITE DEVELOPMENT STUDIES). Maeck, W. J.; Pence, D. T.; Keller, J. H. (Idaho Nuclear Corp., Idaho Falls).

A synthetic zeolite, Linde Molecular Sieve 13X, converted to the silver form strongly adsorbs inorganic and organic species of airborne iodine. As a filter material for the cleanup of iodine from reactor containment atmospheres, it has ideal properties of nonflammability, high temperature operability with adsorption of iodine up to 500°C, retention of iodine up to 1000°C, and a rapid reaction time. Retentions of greater than 99.98% have been measured for elemental iodine and for methyl iodide for a variety of conditions varying from dry flows at room temperature, dry flows at 500°C, and steam-air mixtures. Other promising applications of this type of material to the nuclear industry include cleanup of dissolver off-gas from chemical processing plant operations, filter materials for health physics safety devices such as face masks and air monitors, and adsorbing filters in sampling devices. (auth)

24026 (CONF-680821–, pp 235-62) DEVELOPMENT OF A SAMPLING DEVICE FOR DISTINGUISHING THE FORMS OF IODINE IN A HUMID ATMOSPHERE. Bennett, R. L.; Adams, R. E. (Oak Ridge National Lab., Tenn.).

Analytical samplers, capable of distinguishing and measuring particulate, elemental and the less reactive iodine forms such as methyl iodide, are needed to aid in the assessment of the hazard of an accidental iodine release from a nuclear reactor and to predict its subsequent behavior. A major problem in the application of May pack iodine samplers has been the difficulty in finding the proper sequence of materials that will reproducibly separate the particulate iodine from elemental iodine. An improved sampler has been devised which contains a silver-plated aluminum inlet section that serves as a diffusion battery. The reactive molecular iodine is separated from aerosol particles due to its greater diffusivity. Test data to support this iodine sampling concept are presented. 8 references. (auth)

24027 (CONF-680821–, pp 263-311) RADIOACTIVE AEROSOL SIZE CLASSIFICATION EXPERIENCE WITH A LOW PRESSURE CASCADE IMPACTOR. Parker, G. W.; Buchholz, H.; Martin, W. J. (Oak Ridge National Lab., Tenn.).

Aerosol particles in the submicron range are expected to be released from overheated reactor fuel materials as indicated in numerous experiments which simulate reactor accidents resulting from a loss-of-coolant. Devices to measure aerodynamic particle size in the submicron region are therefore required and a simple, passive, nearly fool-proof device is, particularly desirable. An improvement on a standard instrument, an inertial impactor, which operates at subatmospheric pressure thereby increasing both the mean free path of the air molecules and the Cunningham correction (for the slip of small particles between gas molecules) was conceived and investigated to test this principle. A commercially available Andersen Impactor was first successfully modified for low pressure operation to extend its range to submicron sizes and then an impactor of original design was built, tested and calibrated. The useful range of the new instrument was found to be from less than 0.01 micron to several microns particle diameter. The range is variable and is dependent upon the selected operating pressure. The impactor is assembled and disassembled quickly and employs throw-away impactor plates to facilitate radiochemical analysis and decontamination. 13 references. (auth)

24028 (CONF-680821–, pp 335-8) IN-PLACE IODINE REMOVAL EFFICIENCY TEST. Viles, F. J. Jr.; Weker, R. A.; Goldin, A. S. (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab. Harvard School of Public Health, Boston, Mass.).

Results of the In-Place Iodine Removal Efficiency Test are presented. Measurements of iodine concentrations upstream and downstream of the charcoal filter are listed. (D.C.C.)

24029 (CONF-680821–, pp 354-61) INORGANIC ADSORBERS FOR SAMPLERS TO DIFFERENTIATE INORGANIC AND ORGANIC IODIDE SPECIES. Maeck, W. J.; Keller, J. H.; Beard, H. R.; Cartan, F. O. (Idaho Nuclear Corp., Idaho Falls.).

Experiments to develop a sampler to differentiate and quantitatively measure inorganic and organic iodide species have centered about the use of various silver metal surfaces and various charcoals. The behavior of the silver metal surfaces has been anomalous, especially for submicrogram levels of iodine and for high humidity samples. Recently, a wide variety of materials with emphasis on inorganic compounds that undergo chemical reactions with the iodine species has been studied. A two-component sampler appears promising in which elemental iodine is adsorbed on the first component and organic iodine is adsorbed on the second. Two promising materials for the first component are hydrous zirconium oxide (in the iodide form) which adsorbs elemental iodine by a heterogeneous exchange reaction and finely divided bismuth metal dispersed on a support of activated alumina which adsorbs elemental iodine by a precipitation reaction. The retention of methyl iodine on both materials is less than 1%. Effective adsorbers of methyl iodide for the second component are activated alumina coated with silver nitrate or preferably a synthetic zeolite mineral which has been converted to the silver form. Both materials retain methyl iodide to greater than 99.9%. These materials have been tested in the laboratory with variables of elemental iodine and methyl iodide levels, rate of sample flow, temperature, and relative humidity (including saturated steam flows). In general, their performance is excellent with the iodine species adsorbed as a narrow band at the entrance of the component bed. The anomolous behavior characteristic of silver metal surfaces at low levels of elemental iodine has not been observed. (auth)

24030 (RT/FI-(68)53) AN EXPERIMENTAL STUDY OF THE MACROSCOPIC SELF-SHIELDING EFFECT IN SAMPLES CONTAINING BURNABLE POISONS. Arcipiani, B. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 27p. Dep.

The self-shielding factor of small samples containing very fine grains of Gd_2O_3 or ZrB_2 has been inferred from measurements of their effective absorption in the center of the RANA reactor. The procedure followed and the several assumptions made for the treatment of the experimental data are described. 4 references. (auth)

24031 LEAKAGE RATE DETERMINATION DURING THE INVESTIGATION OF THE LEAKAGE FROM REACTOR SAFETY VESSELS. Walter, Rolf (Univ., Karlsruhe, Ger.); Kesper, Martin; Beier, Gustav; Meyer, Helmut. At. Strom., 15: 7-12(Jan. 1969). (In German).

Reactor safety vessels are generally of welded construction. The responsible supervising authorities generally specify requirements for the absence of leaks in the construction, and this is laid down as the "permissible leakage rate" in figures. The two most usual methods of measurement for determination of the leakage rate, the absolute pressure method and the comparative system method, are described. Finally the two methods of test are compared with one another. References. (auth)

24032 NUCLEAR FUEL ELEMENTS. Gauthron, M. (to Commissariat a l'Energie Atomique). Canadian Patent 799,100. Nov. 12, 1968. Priority date Nov. 5, 1964, France.

A nuclear fuel bundle is described consisting of canned fuel pencils parallel to each other and retained by end grids which rigidly connect the pencils to an outer annular protective jacket. The pencils have a circular cross section and the coolant ducts between them are also circular and bounded by the outer contour of the cans surrounding the pencils. Each can has a polygonal profile in cross section with some of the sides of the polygon being curved so that when several pencils are interconnected they bound these circular ducts. Helical grooves are formed which impart a gyratory motion to the coolant flow thus improving heat transfer. The individual pencils are held at their ends by grids made up of an outer ring bearing collars which cap the ends of the pencils. (F.S.A.) (Canada)

24033 SEISMIC RESPONSE OF NUCLEAR REACTOR CONTAINMENT VESSELS. Lin, Chi-wen (Gilbert Associates, Inc., Reading, Pa.). Nucl. Eng. Design, 9: 234-8(Feb. 1969).

Whether or not nuclear reactor containment vessels vibrate as shells during an earthquake has been a growing concern in recent designs. Existing experiments indicate that the main mode for a steel containment vessel is a lobar mode of high degree and that for an outer concrete shielding wall ovalling appears. These experiments were conducted using a model constructed without sufficient interior structure or stiffening around lumped masses such as airlocks in the wall of the shell. This model is definitely weaker than the actual structure and this probably results in large deformations during vibration tests. The seismic response of a containment vessel based on linear shell theory and a fixed-free perfect cylinder is analyzed. The conclusion is that linear theory does not predict either a lobar type of motion or ovalling if the perfect shell of revolution can be assumed. 11 references. (auth)

24034 STUDY OF TRANSIENT TEMPERATURE DISTRIBUTIONS IN A CYLINDRICAL FUEL ROD. Lee, In-king; Wu, Mowshyoung (National Tsing Hua Univ., Hsinchu, Taiwan). Ho Tsu K'o Hsueh, 6: 1-20(Oct. 1968).

Transient temperature distributions in cylindrical fuel elements under certain conditions are obtained by a numerical method based on difference equations. Results of this method are compared with those obtained by the analytical solutions based on the straight line assumption in the clad. Adequacy of the straight line model is also discussed. (auth)

24035 MANUFACTURE OF POWER-REACTOR FUEL AT RISOE. Soerensen, O. Toft (Danish Atomic Energy Commission, Risoe). Ing. Bygningsv., No. 12, 225-8(1968). (In Danish).

The methods and the equipment developed for pilot plant manufacture of UO_2 pellets and for manufacture of fuel pins by vibratory compaction of UO_2 powders are described. The safety precautions taken against criticality and personnel contamination in the work with enriched uranium are also presented. (auth) (Denmark)

24036 CONTINUOUS IN-PILE MONITORING OF THERMAL NEUTRON FLUX INTENSITY USING ACTIVATION DETECTORS. Knill, G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 77-84 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The primary emission neutron activation (PENA) detectors described measure neutron flux intensity in terms of a mean current generated in the detector. The detectors are small and durable. Small diameter mineral insulated cable can be used to connect them to current measuring instruments outside the reactor. The operating mode is basically simple and no polarizing voltage is necessary. The design and performance of detectors capable of providing information on thermal neutron flux intensity continuously at levels in excess of 2×10^{14} neutrons/cm^2 sec and at a temperature of 500°C for periods up to one year are described. Since the information is continuously available, this type of radiation detector offers considerable scope for coupling to on-line data processing systems. Further developments will aim at improving the high temperature performance and flux exposure lifetime, and investigating fast response detectors. (auth)(UK)

24037 CAMPBELL SYSTEMS FOR REACTOR CONTROL. Fowler, E. P. (Atomic Energy Establishment, Winfrith, Eng.); Metcalf, A. pp 60-7 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

The Campbell system can offer important advantages over counting or dc methods, especially for in-core measurements for reactor control. It is demonstrated that a reactor control instrument can be built exploiting these advantages and achieving the range, reliability and speed of response expected of this class of control equipment. (auth)(UK)

24038 MEASUREMENT OF TEMPERATURE AND NUCLEAR HEATING IN REACTORS: A SURVEY. Dehn, R. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 25-36 of Nucleonic Instrumentation. London, Institution of Electrical Engineers, 1968.

From Conference on Nucleonic Instrumentation, Reading, Eng. See CONF-680939.

Temperature measurements are required as part of the operational instrumentation for all reactors, and also to obtain essential data from experiments. In practice this involves many different types of measurement, covering a wide range of techniques. These techniques are discussed under two main headings: instrumented and uninstrumented techniques, i.e., temperature measurements in positions to which wire connections can be made, where this is not possible. A further important parameter, not unrelated to temperature, in the design of reactors and in the design of irradiation experiments is the total nuclear heating of non-fissile materials. This is best measured by special types of calorimeters. (auth)(UK)

24039 MODELS FOR REACTOR FUEL ELEMENTS WHICH CONSIDER VOID DEPLOYMENT. Merckx, K. R. (Battelle-Northwest, Richland, Wash.). Nucl. Eng. Design, 9: 15-28 (Jan. 1969).

Models for the composite fuel element behavior that are based on end-of-life performance (FIGRO), steady-state behavior (DEFORM), and pseudo-transient behavior (CYGRO), have been developed. The driving potential for the fuel element deformations in these models is the fission-induced swelling behavior of the fuel material. Theoretical models for the swelling behavior of the fuel material have received extensive study. Computer programs based on the system models incorporate some of the proposed swelling models into their methods of evaluating fuel element performance. Models for interactions between the fabricated voids and the fission induced gas bubbles have not been incorporated into these programs. Quantitative evaluations of microscopic void distributions can be obtained from micrographic studies on fuel materials from prototypical fuel element irradiations. These quantitative evaluations would provide the information required to evaluate and to validify the models for internal void redistribution. (29 references) (auth)

24040 THE INVERSION TRANSFORMATION FOR THE SOLUTION OF STATIC THERMOELASTIC PROBLEMS WITH VARIABLE HEAT TRANSFER. Holy, Z. J. (Univ. of New South Wales, Kensington, Australia). Nucl. Eng. Design, 9: 1-14(Jan. 1969).

A method is developed, based on the inversion transformation of a half-space into a sphere, for the determination of temperatures due to localized arbitrary variation of the heat transfer coefficient over the surface of a heat producing infinite half-space. From a knowledge of the temperature distribution, the stresses are obtained by application of Green's functions associated with thermoelastic nuclei of strain. The method is applied to a number of heat transfer distributions, results are compared with known solutions and conclusions are drawn as to the accuracy and applicability of the method. (11 references) (auth)

24041 AXISYMMETRIC THERMAL RESPONSE PROBLEMS FOR A SPHERICAL FUEL ELEMENT WITH TIME DEPENDENT HEAT TRANSFER COEFFICIENTS. Thompson, J. J.; Holy, Z. J. (Univ. of New South Wales, Kensington, Australia). Nucl. Eng. Design, 9: 29-44(Jan. 1969).

The quenching of a sphere with a uniform time dependent heat transfer coefficient, and the response of a sphere with a constant uniform heat source to a changing heat transfer coefficient, are formulated as integral equations for the surface temperature histories. Exact semi-analytical solutions are obtained for a rising or falling exponential approach of the heat transfer coefficient to a new value, and the results computed numerically, to show the good efficiency of an approximate method of solution based on the use of a synthetic kernel. Graphs are presented showing transient surface temperatures, and surface thermal stress histories for a range of Biot number variations. (3 references) (auth)

24042 TRANSIENT THERMAL STRESSES ASSOCIATED WITH SUDDEN INITIATION OF INTERNAL HEAT GENERATION IN AN AXIAL SEGMENT OF A CIRCULAR CYLINDER. Valentin, Richard A.; Schoeberle, Daneil F. (Argonne National Lab., Ill.). Nucl. Eng. Design, 9: 63-80(Jan. 1969).

An exact solution is given for the quasi-static thermal stress field associated with the transient temperatures arising when an infinite, homogeneous, isotropic, right circular cylinder, cooled at its surface by a temperature-independent boundary conductance, suddenly begins, and thereafter maintains, uniform internal heat generation within a finite axial region. The problem is related to the behavior of fuel elements during power transients. The solution form is well suited to numerical evaluation, and extensive results are given. (11 references) (auth)

24043 INELASTIC ANALYSIS OF BOWING IN MULTISPAN FUEL RODS SUBJECTED TO AXIAL THRUST. Newman, John B. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Design, 9: 81-104(Jan. 1969).

Bowing of multispan rod-type fuel elements depends upon axial thrust, heat generation gradients and variations in heat transfer processes. The fundamental aspects of the analysis of axially compressed multispan rods in which there is no interaction between deflections and coolant flow are presented. Elasticity of supports in both axial and transverse directions is considered and the method is applicable to problems in which the thrust depends upon the transverse deflection as well as problems involving prescribed axial thrust. (5 references) (auth)

24044 TRANSIENT HEAT CONDUCTION IN MULTIREGION SYSTEMS WITH NON-LINEAR BOUNDARY CONDITIONS WITH AN APPLICATION TO NUCLEAR REACTORS. Rafalski, Pawel; Szczurek, Jan (Inst. of Nuclear Research, Swierk, Poland). Nucl. Eng. Design, 9: 123-30(Jan. 1969).

A variational method for the determination of the temperature field in a system of N heat conducting regions is presented. This method is used for solving the problem of thermal stresses in a cylindrical fuel element of a nuclear reactor. The radiation and convection phenomena in the gap between the core and the cladding are taken into account. The results are presented in a graph. (7 references) (auth)

24045 VISCOUS CREEP RATCHETTING OF NUCLEAR REACTOR FUEL ELEMENTS. Hibbeler, R. (Youngstown State Univ., Ohio); Mura, T. Nucl. Eng. Design, 9: 131-43(Jan. 1969).

The analysis of creep ratchetting in sealed nuclear reactor fuel elements which are under the influence of variable internal pressure forces and long-time cyclic thermal loadings is described. A simple model which represents the behavior of the cladding when subjected to the imposed loading is established, and the equations pertinent to the solution of the problem are presented for the case when the material creep law is of the form $\dot{\epsilon} = K(\sigma - \sigma_0)$. A method for using this law when the material has an arbitrary creep law variation is presented, and a simple numerical example is worked to illustrate the use of the method when the creep strain rate is related to stress by a simple power law. A study is made to show what effect the material properties and loading have on influencing the creep ratchetting behavior of the model, and the accuracy of the results obtained by the model analysis when applied to reactor fuel elements is then discussed. The analysis appears to offer a realistic compromise between accurate behavior description and mathematical tractability. (8 references) (auth)

24046 TEMPERATURE AND THERMAL STRESS DISTRIBUTION IN SMOOTH AND FINNED CANNINGS DUE TO AXIAL FLUX VARIATIONS. Reynen, J. (EURATOM-Joint Nuclear Research Center, Ispra, Italy). Nucl. Eng. Design, 9: 144-54(Jan. 1969).

Temperature and thermal stress distributions due to thermal neutron flux peaking near the end plugs of fuel rods are determined for both smooth and finned cannings. The theory has been programmed on a digital computer. The code, named ATEAS, handles empirical flux distributions defined at a number of discrete points by assuming a linear flux distribution between adjacent points. (4 references) (auth)

24047 IMPROVEMENTS IN METHOD OF CONTROLLING NUCLEAR REACTOR. (to General Electric Co.). British Patent 1,147,968. Apr. 10, 1969. Priority date May 16, 1966, United States.

REACTOR CONTROL ELEMENTS—assemblies of square lattice, description of drive sequence for 4 independent groups of multiple 3 × 3 (D.C.C.)

24048 ELECTRIC CONTROL APPARATUS. (to Tokyo Shibaura Electric Co., Ltd.). British Patent 1,149,062. Apr. 16, 1969. Priority date Aug. 20, 1965, Japan.

COMPUTERS—use of multiple input digital, for reactor control systems
REACTOR CONTROL SYSTEMS—description of multiple input digital computer (D.C.C.)

24049 HEAT INSULATION FOR NUCLEAR REACTOR PRESSURE TUBES. Montagnani, Mario; Farfaletti-Casali, Flaviano (to EURATOM). U. S. Patent 3,434,925. Mar. 25, 1969. Priority date Mar. 31, 1966, Italy.

An insulated pressure tube for nuclear reactors is described. It consists of two heat barriers, one inside and one outside of the pressure tube. They serve to maintain the tube temperature within a permissible temperature range. The tube is formed of Zr, Be, an alloy of one or both of these metals or other metals or alloys subject to creep at higher temperatures and ductile-to-brittle transition at lower temperatures within the temperature gradient between the fuel within the tube and the temperature outside the tube during operation. (Offic. Gaz.)

24050 GRABHEADS FOR NUCLEAR REACTORS. Deacon, David; Silver, Michael Leonard (to English Electric Co. Ltd.). British Patent 1,147,794. Apr. 10, 1969. Filed Nov. 19, 1965.

Reference is made to grabheads for nuclear reactor fuelling machines. The grabheads contain a number of jaws for gripping a fuel element. The grabhead described includes a solenoid-operated plunger movable axially in the grabhead and connected with the jaws. After release of an object the plunger moves the jaws so as to engage a second object, and so on. The plunger and jaws may be provided with co-operating cam surfaces. (UK)

24051 IMPROVEMENTS IN OR RELATING TO SHIELDED CASKS FOR FUELLING NUCLEAR REACTORS. (to Gulf General Atomic Inc.). British Patent 1,148,604. Apr. 16, 1969. Priority date Apr. 9, 1965, United States.

REACTOR FUEL ELEMENTS—shielded containers for, description of sealed top loaded multiple rod
SHIELDED CONTAINERS—description of reactor fuel element sealed top loaded multiple rod (D.C.C.)

24052 GRABHEADS FOR NUCLEAR REACTORS. Deacon, David; Silver, Michael Leonard (to English Electric Co. Ltd.). British Patent 1,147,795. Apr. 10, 1969. Filed Nov. 19, 1965.

The grabheads described are provided with means for detecting the positions of the associated jaws. The windings of the solenoid operating the plunger which controls the jaws are connected to an AC source and to means responsive to the value of the alternating current. This indicates the position of the plunger and the jaws. A DC operated solenoid may also be used, with AC means for position determination. (UK)

24053 TEST CIRCUIT FOR REACTOR SAFETY CONTROL SYSTEM. Bevilacqua, Frank; Meijer, Christoffel H. (to Combustion Engineering Inc.). U. S. Patent 3,437,556. Apr. 8, 1969. Filed Oct. 23, 1967.

A test circuit for determining the operability of various components of a nuclear power plant safety control system is described. The actuating relays of the control system are provided with double coils, one being operative in the circuitry of the control system and the other operative in the test circuit. The actuation of the control system can be simulated by a test circuit that is completely isolated from the circuitry of the control system. The circuitry of the test system is so arranged that testing of the control system can be conducted while the safety control system remains operative. (Offic. Gaz.)

24054 IMPROVEMENTS IN OR RELATING TO FUEL ASSEMBLIES FOR NUCLEAR REACTORS. Seddon, Thomas; Chetter, John (to United Kingdom Atomic Energy Authority). British Patent 1,148,881. Apr. 16, 1969. Filed May 13, 1965.

Reference is made to cluster type fuel element assemblies with longitudinally disposed spacer grids. The spacer grids are fixed by releasable connection means to some of the fuel pins, so that relative longitudinal movement is prevented between the grids and the fuel pins. The fuel pins are provided with full length protective sheaths with each grid releasably engaged with a sleeve secured to the protective sheath of each fuel pin. The sleeves and spacer grid are constructed to provide longitudinal location for the grid. Alternatively, the fuel pins are provided with protective sheaths in sections with interposed hollow tubes secured to the sheath sections. The hollow tubes are constructed to provide longitudinal location, and also provide fuel pin voids for the accommodation of fission product gases. (UK)

24055 IMPROVEMENTS IN OR RELATING TO CLOSURE DEVICE FOR PRESTRESSED CONCRETE PRESSURE VESSEL PENETRATION. Kinkead, Arthur Norman; McIver, Robert Faulds (to United Kingdom Atomic Energy Authority). British Patent 1,149,154. Apr. 16, 1969. Filed Aug. 4, 1967.

A double closure device is described which comprises a prestressed concrete member covering a metal plate to provide a leak-tight seal to the penetration. The prestressed concrete member may be held in place by tendons which prestress the pressure vessel wall. The member may also be independently prestressed by its own cables. The inner closure member may be in the form of a flat or domed plate sealingly engaging the rim of shutter tubes in the penetration. The inner closure member allows less attention to be paid to the absolute leak-tightness of the concrete closure cap. (UK)

GENERAL

24056 (ANL-7459) THE THERMODYNAMIC PROPERTIES OF P_2, P_4, AND SOME PHOSPHORUS FLUORIDES. O'Hare, P. A. G. (Argonne National Lab., Ill.). Dec. 1968. Contract W-31-109-eng-38. 29p. Dep. CFSTI.

The thermodynamic functions S^0, C_p^0, $(H^0 - H_0^0)/T$, $(G^0 - H_0^0)/T$, and $(H^0 - H_{298}^0)$ were calculated for the ideal gas molecules P_2, P_4, PF, PF_2, PF_3, PF_4, PF_5, and P_2F_4, by the formulas of statistical mechanics. The quantities ΔHf, ΔGf, and log Kf, are also given; where experimental values were not available, estimates were made. The thermodynamic data were calculated at selected intervals between 0 and 6000°K, and also at 273.15 and 298.15°K. Some thermodynamic aspects of the reactions of phosphorus fluorides are discussed. (auth)

24057 (KFK-870) LIST OF THE SCIENTIFIC PUBLICATIONS OF THE ATOMIC RESEARCH CENTER AT KARLSRUHE FOR THE YEAR 1967. (Kernforschungszentrum, Karlsruhe (West Germany)). Nov. 1968. 71p. (In German). Dep.

24058 (KFK-900) SAFEGUARDS SYSTEM STUDIES AND FUEL CYCLE ANALYSIS. Haefele, W.; Gmelin, W.; Gupta, D.; Larisse, J.; Winter, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Dec. 1968. 49p. (CONF-681101-16). Dep.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

In the present and future era of commercial nuclear power generation, the nuclear material flow through the various nuclear facilities in a fuel cycle and the principle of safeguarding effectively the flow of fissile material by use of instruments and other techniques at certain strategic points appears to be well suited for a safeguards system. In order to assess the requirements of such a safeguards system, a detailed systems analysis is necessary. Besides establishing quantifiable criteria for a safeguards system, such an analysis enables one to set the target values of instruments and methods as well as other objectives of development. Extensive experiments in industrial scale facilities are also required to demonstrate the feasibility of such a safeguards system. The various phases of activities carried out in this area at the Karlsruhe Research Center and the system analytical approach followed to establish a safeguards system based on the above principle are described. The safeguards exercise carried out in the plutonium fabrication plant ALKEM at Karlsruhe is described. The method of assessing the relative importance of the chosen strategic points, preparation of material balance and establishment of different types of statements, which can be made by an inspection authority, are discussed. The possibility of estimating the dynamic behavior of the process inventory for a given plant lay-out is indicated. It is shown that this principle can be effectively realized also in existing plants of the ALKEM type. (auth)

24059 (LA-4083) TESTS OF THERMODYNAMIC PREDICTION INVOLVING THE MEASUREMENT OF TIN-MERCURY SOLUTION ACTIVITIES BY DIFFERENT TECHNIQUES. Elliott, Guy R. B.; Conant, Donald R. (Los Alamos Scientific Lab., N. Mex.). Dec. 10, 1968. Contract W-7405-eng-36. 13p. Dep. CFSTI.

Published activity measurements on tin–mercury solutions are discussed along with other tests of thermodynamic theory, particularly the Duhem relationship. It is concluded that thermodynamic theory quite possibly is inexact when applied to real solutions. (auth)

24060 (RFP-1144) OPTICAL CALIPER. Utley, L. William (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Feb. 24, 1969. Contract AT(29-1)-1106. 15p. Dep. CFSTI.

An Optical Caliper, being designed and constructed for absolute, noncontact measurements of length or diameter without the use of a master reference part, is described. The instrument utilizes two white-light interference microscopes as null positioners and a laser fringe-counting interferometer as the actual measurement means. The instrument is capable of a measurement range from zero to six inches. Details of the microscopes, reference standard, and fringe-counting interferometer are given, together with an analysis of measurement error. (auth)

24061 (TID-5059(9th Rev.)) CORPORATE AUTHOR HEADINGS USED BY THE U.S. ATOMIC ENERGY COMMISSION IN CATALOGING REPORTS. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Feb. 1969. 174p. CFSTI.

A revision of the USAEC authority list of corporate names, printed from a computer-maintained file, is presented. It conforms to the cataloging rules adopted by the Committee on Scientific and Technical Information (COSATI) of the Federal Council for Science and Technology. (W.H.K.)

24062 (TID-25004) AN ANALYSIS OF WORLD-WIDE CONTRIBUTIONS TO NUCLEAR SCIENCE ABSTRACTS, VOLUME 22 (1968). Vaden, William M. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Apr. 1969. 97p. Dep. CFSTI.

A brief introduction to the computer-based system for categorizing articles abstracted for Nuclear Science Abstracts by such elements as author, title, source, journal, etc., is presented. The methods used for selection and categorization of NSA materials are described. The global contributions to NSA based on these categorization methods are examined. Three appendices include an analysis of six top countries on basis of individual contributions, a complete listing of journals contributing to NSA, Vol. 22, and a ranking of the top 350 journals contributing to NSA, Vol. 22. (B.G.D.)